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The Marine Observer

A quarterly journal of Maritime Meteorology

Volume XXXII No. 195

January 1962

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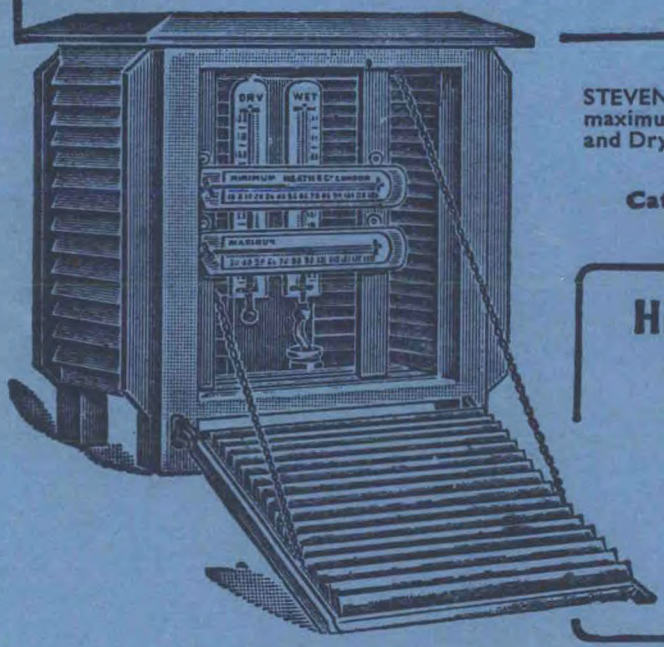

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The photographs illustrate the appearance of the sea corresponding to the Beaufort Wind Scale and are intended to aid observers in estimating the strength of the wind in knots when making their routine weather reports. They will also be of benefit to yachtsmen and others, in predicting their state of sea from wind forces given in radio weather bulletins.

The range of wind speed and the mean wind speed are quoted for each force; the description of the sea according to the 'Sea Criterion' laid down by the World Meteorological Organisation is also given.

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THE MARINE OBSERVER

A Quarterly Journal of Maritime Meteorology
prepared by the Marine Division of the
Meteorological Office

Vol. XXXII

1962

M.O. 717 AIR MINISTRY

THE MARINE OBSERVER

A QUARTERLY JOURNAL OF MARITIME METEOROLOGY PREPARED BY THE MARINE DIVISION OF THE METEOROLOGICAL OFFICE

VOL. XXXII No. 195 JANUARY 1962

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Editorial

"Sirs, I perceive that this voyage will be with hurt and much damage, not only of the lading and ship, but also of our lives."

In these words, St. Paul, mindful of the contrary winds already encountered and the onset of winter, warned his captors to delay leaving Crete, on their voyage from Sidon towards Rome, until the winter would be over. Today they are mirrored in the announcements on the B.B.C. light programme—"Attention all shipping! The Meteorological Office issued the following gale warning at . . ." But St. Paul had no listeners other than the centurion, who held him in chains, and the master of the ship; his forecast was not backed up by the observations of any voluntary observing fleet, and it is perhaps not surprising that the chances of incurring the displeasure of Rome at the delay in delivering a valuable human cargo were weighed against the chances of encountering heavy weather, to the detriment of the latter. The sequel is history, firstly the deceptive southerly wind blowing softly, then the tempestuous wind, called Euroclydon, known today as the Gregale, a winter wind of great fury and force blowing from the north-east, the inability to heave-to and the decision to run, latterly under bare poles, the jettisoning of the cargo and the final stranding of the ship on the Island of Malta. The comment of St. Paul (who by this time must undoubtedly have been considered a Jonah by the ship's company) is apt. "Sirs, ye should have hearkened unto me, and not have loosed from Crete." This remark, however, is not mirrored in any present-day pronouncement from the Meteorological Office though one is sometimes tempted to think that it could quite justifiably be.

Some eighteen hundred years were to pass after St. Paul's verbal forecast before Admiral FitzRoy issued his first visual gale warning and those eighteen hundred years must have seen many, many marine disasters which might have been prevented had there been some sort of warning system or even if a lone voice such as that of St. Paul could have been heard.

The Times of 2nd February 1861 announced, "On Wednesday last the following notice was given at Aberdeen, Hull, Yarmouth, Dover, Liverpool, Queenstown, Valentia and Galway (besides other places) by telegraph—'Caution—Gales threatening from south-west and then northward. Show signal drum'."

The drum referred to signified that a dangerous wind could be expected from nearly opposite quarters successively. A cone point up or point down showed its probable first direction with the same meaning as today.

Later, the same paper reported favourably on the new system. . . . "The growth of this new department [the Meteorological Office] seems to bear the same relation to the Shipwreck Relief Society and the Lifeboat Society that preventive medicine does to remedial medicine. Indeed, as we progress in knowledge, we are beginning to find out that prevention is better than cure, and what is more to the purpose, we are becoming enabled to put this prevention into practice." But economic necessity still held Prudence by the heels and in reporting on the gales of that year Mitchell's Maritime Register stated that in far too many instances the warnings were not being regarded by those for whom they were intended ("The Masters and crews of some ships have paid for their hardihood and temerity"). Without disrespect to our first Director, Admiral FitzRoy, one can imagine that he said, or at least thought, "Sirs, ye should have hearkened unto me . . .".

Today there are happily few seamen who will ignore a gale warning, though to many ships remote from a safe harbour and with little speed at their disposal it will mean only added discomfort and a risk that has to be faced with as much fortitude and seamanship as possible. And this will go on. The gale warnings and weather bulletins for shipping, the climatological, ocean current and ice atlases, and the other services for shipping which the observations of the Voluntary Observing Fleet enable us to provide, will undoubtedly improve with the advance of new

techniques. Tomorrow's ships may be operated by men skilled in crafts far removed from our conception of seamanship today: perhaps the building into certain Leningrad trawlers of electronic computers which will navigate, control the engines, search for fish, operate the gear and processing equipment whilst a special 'television eye' automatically regulates the depths of the trawl depending on the concentration of fish, is a shadow of things to come. But the wind and the sea will not change and however much the mariner may be assisted by technology, in the end it is his own competence in assessing the elements which will draw the line between success and failure, between safe arrival and marine disaster.

It falls pleasantly to the lot of the writer of the Editorial in the January number of *The Marine Observer* every year to send to all members of the Voluntary Observing Fleet our very best wishes for the coming year. This is no mere formality, for each observer is more to us than just a name in a meteorological logbook or a name on a card in a filing cabinet. We like to think that every issue of *The Marine Observer* is, in a way, a letter from home to members of a large family and every communication from members of that family to the parental home in Bracknell is welcome, even if it is one of disapproval or condemnation. That our words will be read in many cases long after the sound of the last sixteen bells has died away in no way diminishes the sincerity of our wish that for you all 1962 will be a year of happiness, pleasant voyages and good landfalls.

L. B. P.

THE MARINE OBSERVERS' LOG

January, February, March

The Marine Observers' Log is a quarterly selection of observations of interest and value. The observations are derived from the logbooks of marine observers and from individual manuscripts. Responsibility for each observation rests with the contributor.

TROPICAL REVOLVING STORM

South Pacific Ocean

m.v. *Trecarrell.* Captain I. M. Price. Balboa to Auckland.

15th March 1961, 0000 GMT. Wind 010°, 4 kt.; barometer 1008·4 mb., falling. Position of ship: 15° 54′S, 151° 48′W.

0230 Drizzle commenced. Swell increasing rapidly.
0430 Wind increased to NNE, force 4.
0740 Heavy rain squalls.
1200 Wind, 360°, 37 kt. Barometer 997·3 mb., falling. Very heavy rain squalls.
1800 Wind 310°, 68 kt. Barometer 995·7 mb.

16th March, 0000 GMT. Wind 280°, 52 kt.; barometer 997·9 mb.

0100 Blue sky visible momentarily to the north.

1300 Wind backed to 250°. Torrential rain.
1800 Wind 250°, 37 kt. Barometer 1002·2 mb.
2310 Wind backed to 230°.

17th March, 0000 GMT. Wind 230°, 29 kt.; barometer 1003·0 mb.; sky clearing rapidly.

Position of ship: 17° 42′S, 155° 30′W.

m.v. *Trevaylor*. Captain W. F. Denyer. Balboa to Suva.

17th March 1961. At 1330 GMT, when 45 miles SE of Savaii Island in the Samoa Group and proceeding on a course of 255° towards Fiji, the barograph trace was noticed to be falling sharply. The mercurial barometer read 1004·4 mb. after correction for height, latitude and temperature. The correction for diurnal range was plus 0·6 mb. The pressure was thus just 5 mb. below that shown as the monthly normal for this locality. This fact, together with the fresh (15 kt.) NW'ly wind and increasing NW'ly swell, gave rise to the suspicion that a tropical storm was forming nearby. However, at 1400 GMT the barograph trace was level and at 1500 GMT it was rising. At this time the ship was clearing the lee of Savaii Island. No storm subsequently developed and the sudden fall in pressure was attributed to a localised low pressure area being formed in the lee of Savaii and Upolu Islands, which are about 6,000 and 3,000 ft. high respectively.

Position of ship: 14° 21′S, 171° 36′W.

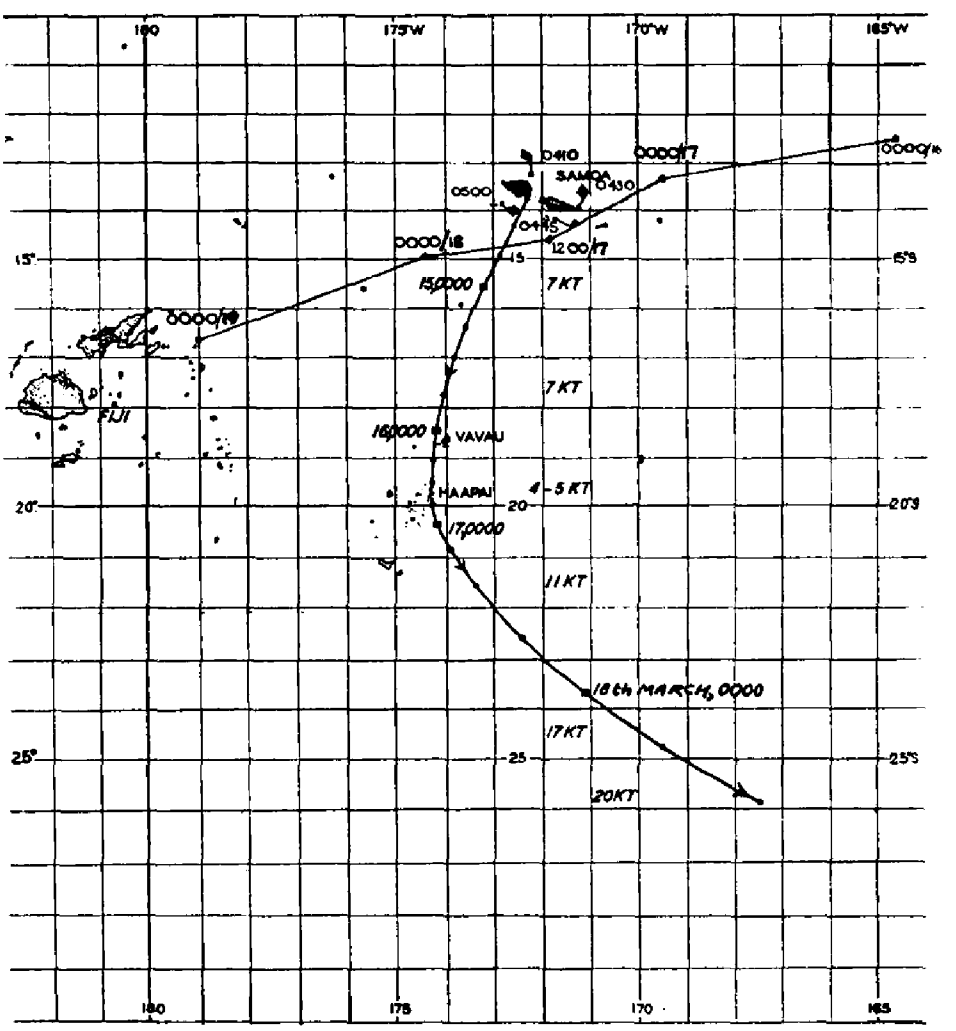
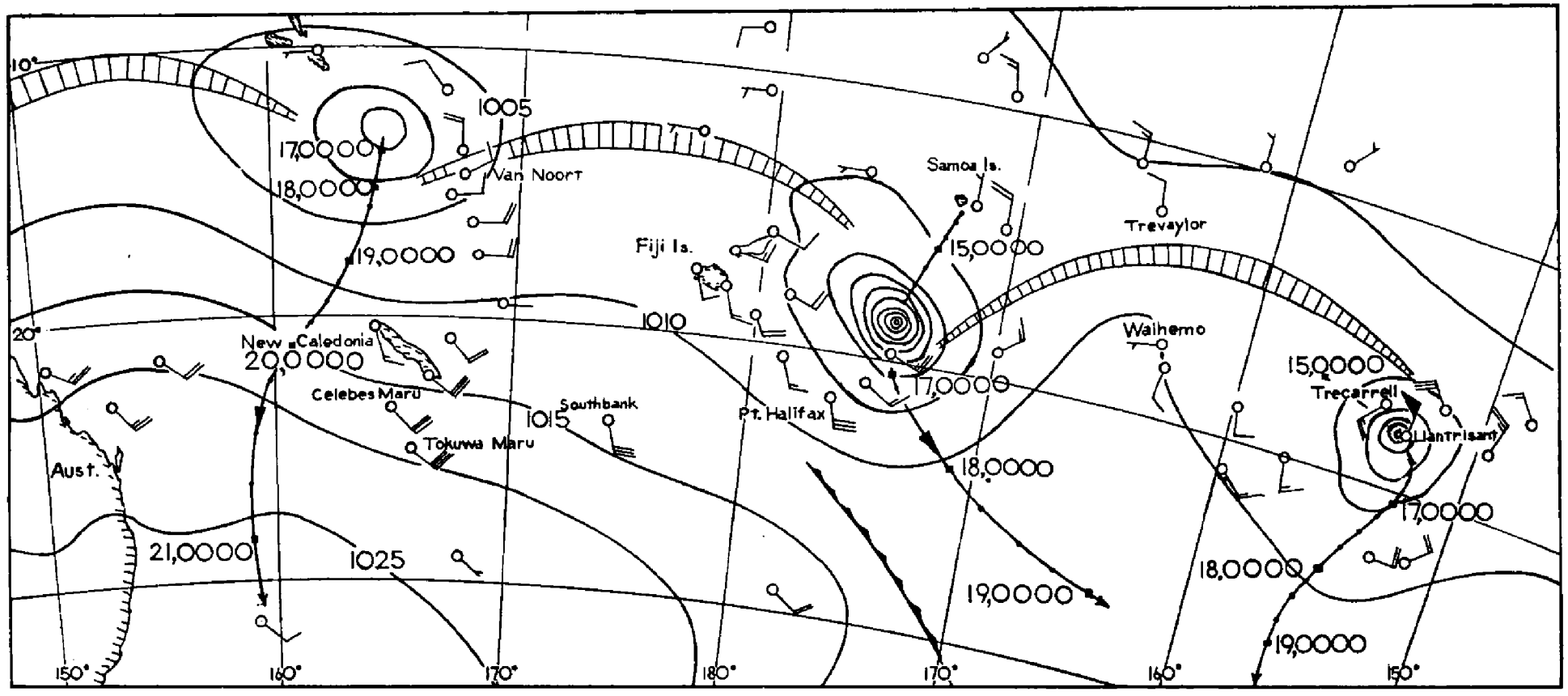


Chart kindly supplied by New Zealand Meteorological Service

Fig. 1. Track of centre of the storm experienced by *Trevaylor*
(Aircraft reports around Samoa are for 14th March)



Inter-tropical convergence zone

Chart kindly supplied by New Zealand Meteorological Service

Fig. 2. Isobaric analyses for 0000 GMT on 16th March 1961, and storm tracks.

Note 1. *Trevaylor's* observations embrace most of the well known prognostics of a tropical revolving storm in the vicinity and this was, in fact, the case. At the time of the observation a hurricane was centred approximately 500 miles south of the vessel and she passed through the northward-extending trough of low pressure of this storm. However, as the storm was then moving SE this explained why no further signs of it were seen.

Note 2. Mr. I. S. Kerr, of the New Zealand Meteorological Service, comments as follows:

"The summer just passed was not particularly remarkable as regards the number and intensity of cyclones in the South Pacific but was somewhat unusual in that four of them occurred in the month of March and three of them were in existence at the same time. The first of these to develop the proportions of a storm passed to the west of Tahiti on 13th March; and, on the same day, there were signs of a cyclonic disturbance north west of Samoa. [This was the storm referred to in *Trevaylor's* observation.] Warnings were issued in respect of both storms although little was known of the latter. On the afternoon of the 14th a R.N.Z.A.F. reconnaissance from Fiji placed the centre west of Apia and just south of Savaii (see Fig. 1). It then moved SSW at an average speed of about 7 kt. On the afternoon of 15th it passed 20 or 30 miles east of Keppel Island where the wind speed reached only 25 kt. The next day, shortly before noon, the hurricane struck Vavau. At this stage it was recurving towards the SE and its average speed of movement was 4 to 5 kt. Two people were killed on Vavau and between 8,000 and 9,000 people rendered homeless; the banana plantations in both Islands had been completely wiped out and the copra industry was also badly hit. The total loss was expected to exceed £20,000.

"On a recurving track the storm passed well to the east of Nukualofa and its speed of movement increased to about 20 kt. as it moved away to the SE. On 18th it crossed the track of the *Waihemo* in about 25°S, 168°E and at 1200 GMT the centre was estimated to be to the NE of the ship and within 50 miles. Although the pressure did not fall below 990 mb., some very severe weather was experienced with a wave height estimated at between 20 and 30 ft.

"At about the time this hurricane was passing over the Tonga Group, another cyclone 1,200 miles to the east was moving southward just to the west of Mopelia in the Society Islands. At 1800 GMT on 15th March s.s. *Trecarrell*, just south of Mopelia, reported a NW wind of 68 kt. There were signs of yet a third cyclone developing west of Luganville in the Hebrides. Fig. 2 shows the weather map for 0000 GMT on 16th March with the tracks of the three cyclones. The western one developed rather slowly and moved towards the SSW. It passed 100 to 150 miles to the west of the northern end of New Caledonia on 20th March. It then moved rapidly northward to pass near to Lord Howe Island at about 0900 on 21st March, swung to the SE, slowing up and crossing southern New Zealand on 24th. Little is known of the intensity of the storm in its earliest stages but a number of ships about 100 miles from the centre at different times reported winds of 50 kt. When it passed over Lord Howe Island the pressure gradient in the central region, diameter 50 to 100 miles, was very small. The pressure at Lord Howe Island did not fall below 990 mb.

"On 17th and 18th March, when the tropical storm was still west of the New Hebrides, there was an intense anticyclone in the Tasman Sea. As a result there were very strong SE to E winds blowing over a very large area east of Queensland and south of New Caledonia. The fetch near the Queensland coast was considerable and it was in the seas generated by these winds that the small steamer *Verao* foundered on the night of 18th March.

"Minor tropical depressions continued to dominate the region, particularly north of Fiji, until near the end of March but suddenly the low pressure trough retreated towards the equator and the easterlies again prevailed."

VIOLENT STORM

North Atlantic Ocean

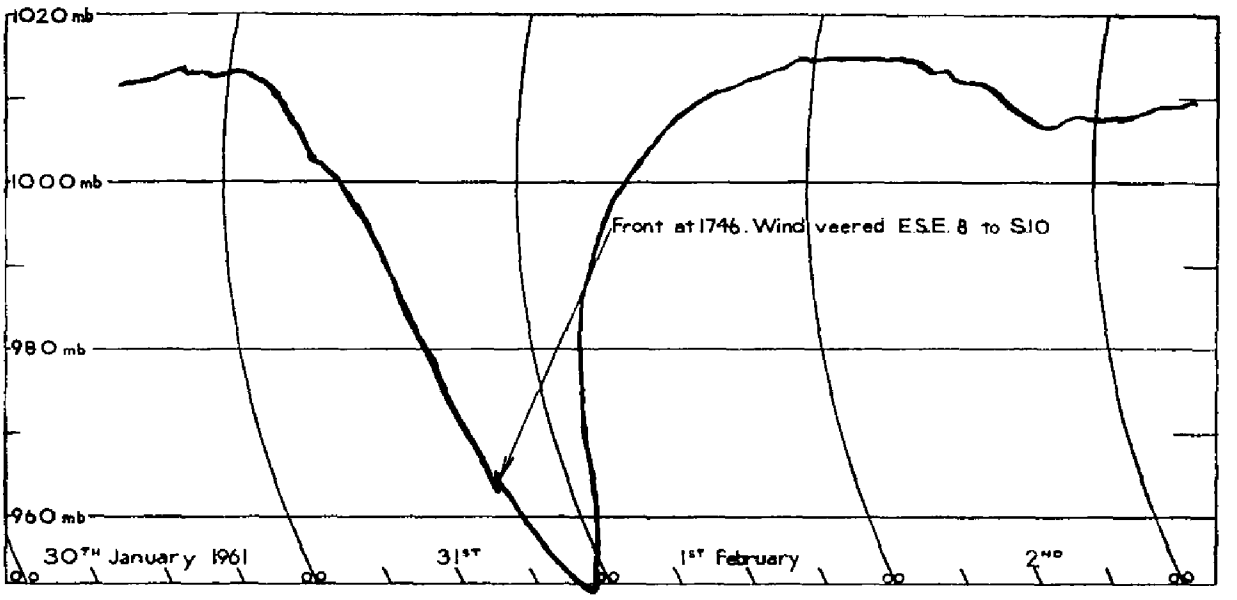
s.s. *New York City*. Captain F. W. Harris. Halifax to Bristol Channel ports. Observers, the Master, Mr. A. N. Couch, Chief Officer, Mr. T. Chappell, 2nd Officer and Mr. J. H. Whitcher, 3rd Officer.

31st January 1961. At 0430 GMT the wind, which had been from a westerly direction, came round to ENE, force 3, and began to freshen with a rapidly falling barometer, until by 1430 it reached ESE, force 8. Throughout the period, continuous light snow, sleet and then rain, was experienced. At 1746 the vessel passed through a line of heavy rain which was seen on the radar to be orientated 120°–300°

approximately, and taken to be a front. At this point the wind veered to the south and increased to force 10: the barometer rose 3 mb. and then began to fall rapidly again. Between 2030 and 2200 the wind moderated becoming variable, force 4, with a very heavy confused swell. The barometer reached its lowest value of 28·00 in. at 2200 and then started rising very rapidly: the wind freshened simultaneously to WSW, force 8. As the barometer climbed sharply, the wind force increased greatly, as shown in the following table, until between 0100 and 0330 on 1st February it was estimated as W'ly, force 12, with a speed of 70–80 kt. The visibility at this time was almost zero, due to rain, flying foam and spray. The vessel was rolling and pitching very violently and shipping heavy seas in a mountainous sea and precipitous swell of at least 50 ft. in height.

Extract from the deck log

Date	GMT	Wind Direction	Wind Force	Barometer	Remarks
31st Jan.	0430	E'ly	3	—	
(Position at 0000 —47° 12'N, 45°	0630	ENE	3	29·60	Slight sea and moderate W'ly swell. Overcast/cloudy. Good visibility.
48'W; at 0600—	1030	E'S	6	29·40	Rough sea and moderate swell. Overcast with continuous sleet, and latterly
47° 48°N, 43° 56'W; at 1200—					rain. Poor visibility.
48° 6'N, 42°	1430	SE	8	28·83	Rough sea and heavy swell. Overcast
36'W; at 1430—					with continuous sleet and then rain.
48° 22'N, 41°					Poor visibility.
48'W; at 2200—	1746	S'ly	10	—	
48° 40'N, 41°	1830	S'ly	10	28·24	Very rough sea and very heavy con-
0'W)					fused swell. Overcast with con-
					tinuous heavy rain. Poor visibility.
	2030	Var.	4	28·06	
	2130	WSW	8	28·03	
	2200	W'S	10	28·00	
	2230	W'S	10	28·05	Very rough confused sea and very heavy confused swell.
	2330	W'S	10	28·17	
1st Feb.	0030	W'ly	11	28·21	
(Position at 0000	0130	W'ly	11–12	28·50	
—48° 12'N, 41°	0230	W'N	12	28·77	Precipitous sea and swell (W'ly). Over-
48'W; at 1800					cast with frequent rain squalls at first.
—48° 30'N, 40°					Visibility zero in flying foam and
36'W)					spray.
	0330	W'ly	12	—	
	0430	W'ly	11–12	29·07	
	0530	W'ly	11–12	29·25	
	0630	W'ly	11–12	29·35	Mountainous seas: precipitous swell.
					Continuous heavy rain squalls. Poor
					visibility.
	0830	W'ly	10–11	29·50	
	1030	WSW	10	29·70	Similar to above.
	1130	W'S	10–9	—	
	1230	W'ly	9	—	
	1330	W'ly	9–8	—	
	1430	W'ly	8	29·76	Very rough sea and very heavy swell. Cloudy and clear.
	1830	W'ly	8–7	29·84	Rough following sea and very heavy W'ly swell. Cloudy. Good visibility.
	2230	W'ly	5	29·90	Rough sea and heavy W'ly swell. Overcast.
2nd Feb.	0000	SW	4–5	29·91	Moderate sea and heavy W'ly swell.
(Position at 0000 —49° 0'N, 38° 24'W)					Overcast with intermittent light rain.



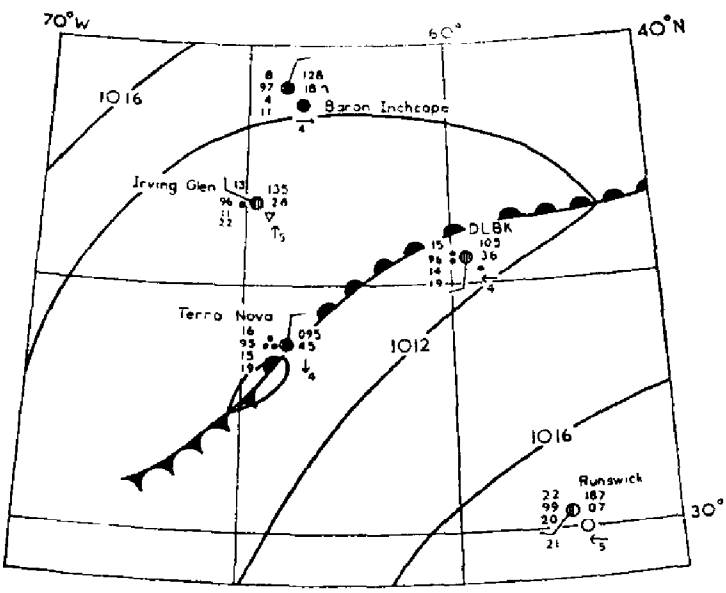
New York City's barograph trace.

From 0330 the wind moderated slowly until 1030 when it backed to WSW, force 10; at 1230 it backed to W again. The rise in pressure was now slowing appreciably.

The vessel was hove-to between 2130 on 31st January and 1330 on 1st February after which time an E'ly course was resumed, the wind then being W'ly, force 9–8. From 1330 onwards the wind continued to moderate and by 0000 on 2nd February it was SW, force 4, the barometer reading now being 29·90 in. The sky was heavily overcast throughout the period and for the most part the visibility was poor. No temperatures were taken after 2330 on 31st January as both dry and wet bulb thermometers vanished without a trace from the Stevenson screen, which was itself badly damaged. The mercurial barometer had been out of order for some weeks previously and it was smashed at the height of the storm.

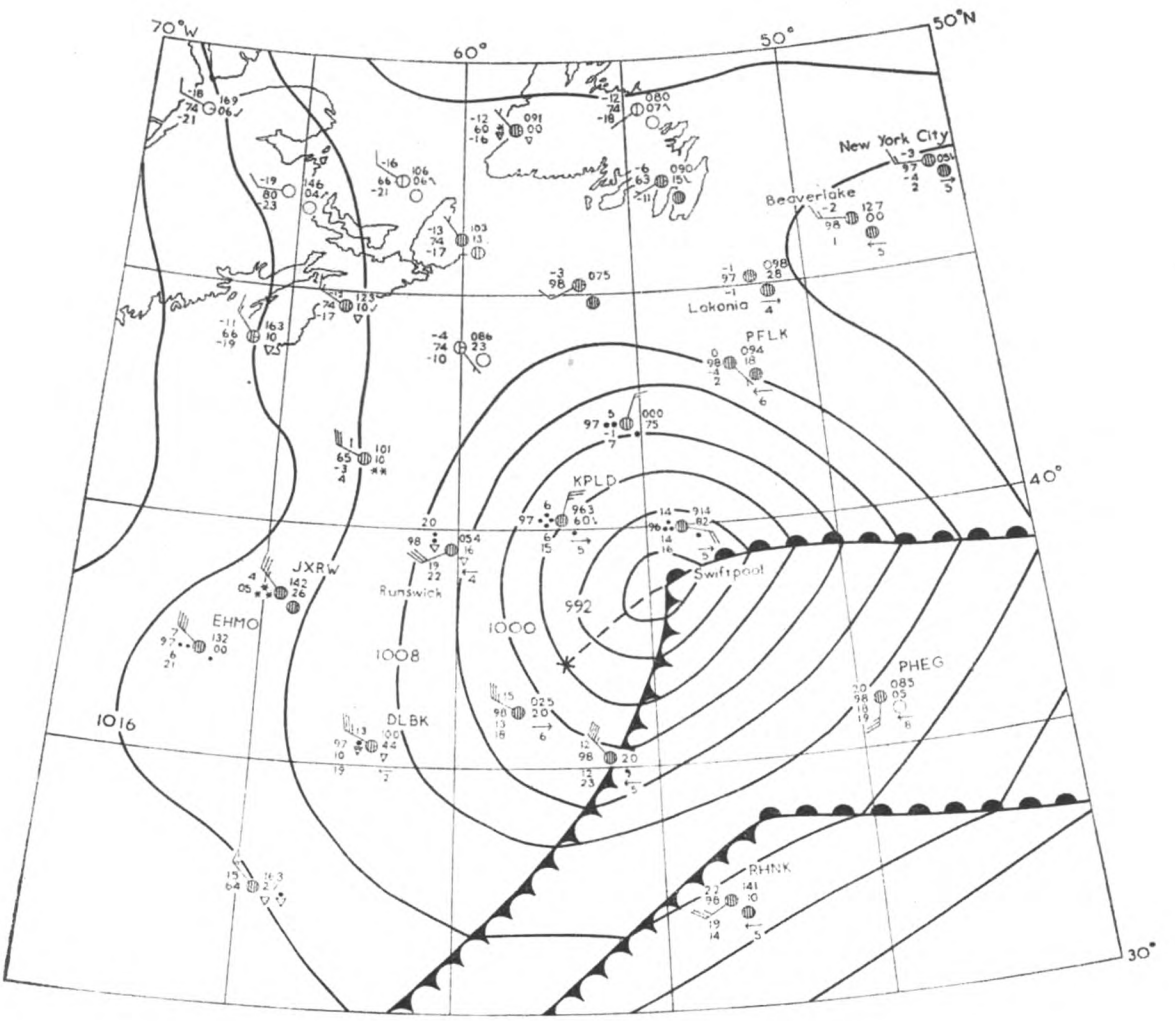
Position of ship on 31st: at 1430, 48° 22′N, 41° 48′W.
at 2200, 48° 40′N, 41° 00′W.

Note. This is a typical case of a frontal wave rapidly developing to a severe and dangerous depression, as shown in the four extracts from synoptic charts reproduced here. It will be seen how effectively its development could be followed by ships' observations. The ship's

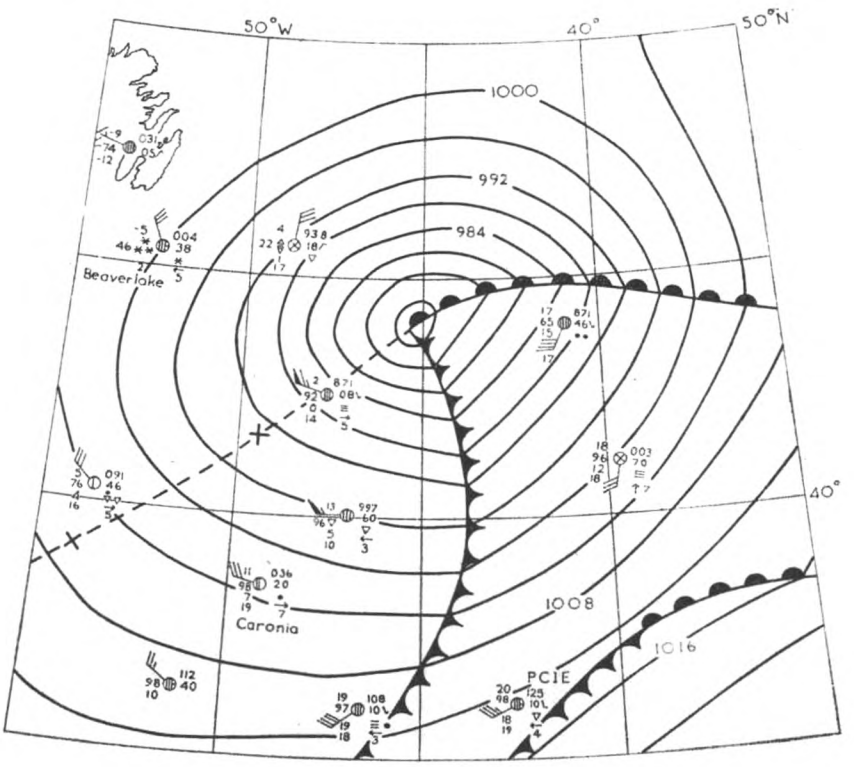


(Temperatures are in °C)

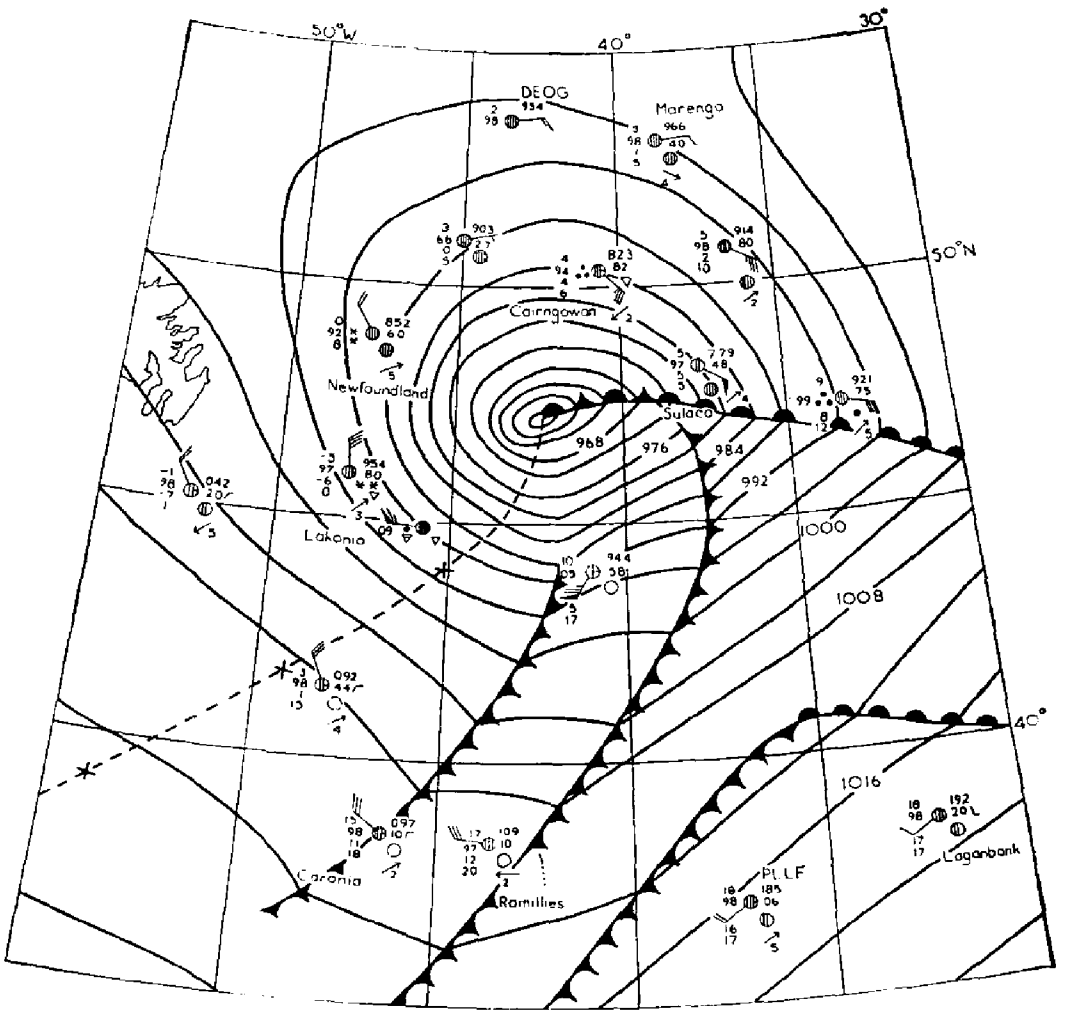
30th January 1961, 1200 GMT.



31st January 1961, 0000 GMT.



31st January 1961, 1200 GMT.



31st January 1961, 1800 GMT.

meteorological logbook makes it clear that urgent navigational duties precluded the transmission of the 1800 GMT observation on 31st from *New York City*, but the Central Forecast Office, when consulted concerning this sequence of observations, said that had such a transmission been possible their analysis would have been amended. Weather reports were transmitted from her, however, at 1200 on 31st January and at 0000 and 1800 on 1st February.

The rapid development of the depression was due to the very cold northerly air stream that entered the rear of the depression during its formation. This stream contained a number of secondary cold fronts (successive steps of colder air following the initial cold front) which occluded into the depression, increasing the contrast between the cold air and that in the warm sector.

WATERSPOUT

Indian Ocean

m.v. *Silverbrook*. Captain P. L. Hopkins. Abadan to Yokohama. Observer, Mr. D. V. Wood, 3rd Officer.

10th February 1961. Shortly after 0800 LMT a waterspout bearing 070° from the ship was seen to be forming, and at 0805 a disturbance was observed on the sea surface, eight miles away by radar. To the northward of the spout there was precipitation and two distinct separate echoes were seen on the radar. By 0808 the spout was complete, and 675 ft. in height by sextant angle; at this time it was surrounded by light showers. The hollow centre of the column was clearly seen through prismatic binoculars but neither the direction nor speed of rotation could be ascertained. At 0811 a break appeared at the lower end of the column and precipitation increased. The break widened as the shower became heavier and by 0814

the spout was no longer visible, being lost to sight in the rain: it was not seen again after the rain ceased. After 0808 the disturbance on the sea surface was no longer discernible as a separate echo on the radar, but it was visible through binoculars until 0812. Air temp. 82°F, wet bulb 76·5, sea 82·5°; cloud predominantly large Cu. and As.; wind NNW, force 2.

Position of ship: 6° 45′N, 78° 53′E.

Note. m.v. *Silverbrook* experienced on this occasion conditions typical of Indian Ocean monsoon air (north-east monsoon) near the equatorial trough or convergence zone, in which there are incipient tropical storms.

ABNORMAL PRESSURE CHANGES

North Atlantic Ocean

o.w.s. *Weather Watcher.* Captain T. J. Morgan. At Station 'I'.

19th February 1961. A storm of unusual violence was experienced during the morning, in the course of which the corrected pressure rose from 973·4 mb. at 0900 GMT to 997·0 mb. at 1200—a change of 23·6 mb. The fastest rise occurred between 0930, when a cold front passed, and 1030: this amounted to 16 mb. During the storm, the winds shown below were recorded by the anemometers on the mainmast:

Time (GMT)	Wind Direction	Wind Speed (kt.)
0000	S	35
0300	S′E	45
0600	S′E	50
0650	S′E	62
0930	WSW	75
1030	WSW	70
1200	W′S	45
1500	SW′W	40
1800	SW	38

At the height of the storm, flying spray reduced the visibility to less than 55 yd. Waves, which earlier had been 25 ft. high, increased to 40 ft.

Position of ship at 0900: 59° 12′N, 18° 54′W.

Note. In the British Isles, rises or falls of 20 mb. in three hours are rare, but when they do occur they tend to take place near the Atlantic coasts and in situations similar to the North Sea storm of 31st January 1953. Extreme changes in twelve hours amount to about 40 mb. Pressures are mainly low when changes of this rapidity occur—i.e. essentially in cyclonic situations: values of pressure above 1,015 mb. would seldom enter into it.

Great changes of pressure are particularly common near the coasts of Greenland and Antarctica. Changes of 20 mb. in 3 hours probably occur at some time every year and changes of 60 mb. in 24 hours are not unknown.

Mediterranean Sea

s.s. *Venassa.* Captain J. C. Nettleship. Rotterdam to Banias (Syria).

24th January 1961. About 0310 GMT the barometer began to fall rapidly, accompanied by severe squalls and heavy thunderstorms. In 1½ hours pressure fell 11·6 mb., and then started to rise again just as rapidly. The amount of rise, however, was not so great as the fall and at approximately 0645 the barometer steadied up at 997·4 mb., having risen 7·6 mb. The wind during the period was mainly force 7, from between NE and SE, but gusts of force 9–10 occurred during the squalls. At 0000: air temp. 58°F, wet bulb 56°. At 0600: air temp. 52°, wet bulb 52°.

Position of ship: 36° 50′N, 13° 12′E.

Note. These severe conditions occurred in a secondary low in a weakening Atlantic depression

which had moved over Spain. The secondary moved on into the western Mediterranean Sea alone and intensified.

The ship was situated in the vicinity of the cold frontal boundary between Atlantic air and Mediterranean air probably of desert origin.

FOG

Off New Caledonia

m.v. *Hudson Deep*. Captain J. Gibbons, D.S.C. Port Kembla, N.S.W. to Noumea.

1st February 1961. Patches of thick fog were encountered during the morning, 5 miles off New Caledonia reef, but they cleared when the vessel was inside the reef. The fog was very surprising as it is almost unknown at Bulari Passage. It was brought in by the S.E. trades, in banks which did not appear to be particularly humid, as nothing was damp. In contrast to this, the passage from Port Kembla was noteworthy for the very high humidity experienced in the vicinity of Middleton Reef. There the air was so damp that condensation dripped continuously from the ship's super-structure. The air temp. rose from 76°F at 1800 GMT on 31st January to 83° at 0000 on 1st February. During the period the wind was calm.

Position of ship at 1800 GMT: 23° 42′S, 164° 36′W.

Note. The area over which m.v. *Hudson Deep* encountered fog is usually uniform in both sea and air temperature. The fog may have been caused by some local upwelling of cold water from layers of the sea well below the surface. (The sea temperature was not recorded by *Hudson Deep* as she is a Supplementary Ship and so not equipped with a sea-temperature bucket.)

High humidity in the passage from Port Kembla is not unusual at this time of the year owing to the prevalence of on-shore winds bringing maritime air on to the coast where local upwelling of cold water is quite frequent. This cold water often flows away from the coast eastwards and north-eastwards.

SEA SMOKE

North Atlantic Ocean

m.v. *Swiftpool*. Captain E. A. Snaith. New York to Göteborg. Observer, Mr. J. Landels, 2nd Officer.

5th March 1961. Between 1135 and 1148 GMT a fierce squall crossed the ship, accompanied by heavy hail, and almost immediately sea smoke was seen on the surface of the sea. It increased and started rising, causing the visibility to be greatly reduced. The smoke continued for 2 min. after the squall had passed and then quickly dispersed. Air temp. 41°F, wet bulb 39°, sea 60°; wind NW, force 7.

Position of ship: 42° 18′N, 46° 06′W.

Note. Sea smoke usually occurs when very cold air flows over a warm sea: these conditions held on this occasion. It is possible, however, that the condensed water particles that formed the sea smoke may have been caused in part by some local dynamical reduction in atmospheric pressure associated with the fierce squall. The rapid dispersal of the water particles was probably associated with the strong wind.

Off Cape Hatteras

s.s. *Empress of England*. Captain C. L. de H. Bell, D.S.C., R.D. Nassau to New York. Observer, Mr. J. B. Walker, Chief Officer.

27th January 1961. The photograph opposite page 32 was taken at 0700 LMT when 25 miles SE of *Diamond Shoal* light-vessel. The sea smoke disappeared when the vessel entered cold water again, 2 hours later, after clearing the Gulf Stream. Air temp. 30°F, sea 70°; wind NNW, force 6; weather, cloudy.

Note. This is an excellent photograph. Sea smoke is necessarily shallow because of the rapid

vertical mixing associated with the large vertical temperature gradient adjacent to the sea surface. In the present case there was a difference of no less than 40°F between the air and sea temperatures, the area being covered by an Arctic air stream coming in from NNW.

LINE OF DEMARCATION

Gulf of Panama

s.s. *Gothic*. Captain R. G. James. Wellington to Balboa. Observers, the Master, Mr. R. O. Guille, Chief Officer and Cadet Dancaster.

5th March 1961. At 2330 GMT a line of demarcation between two water masses was observed lying in a NE–SW direction. Across the line, the sea temperature dropped from 85° to 71°F: ten minutes previously, the air temperature had fallen from 76° to 71°F. The wind was mainly NE'ly and varied from force 2 to force 4. There was a low NE'ly swell.

Position of ship: 7° 12'N, 80° 08'W.

Note. This observation appears to be generally similar to that recorded by m.v. *Port Pirie* on 9th April 1959, in the same area. An account was given on p. 56 of *The Marine Observer*, April 1960.

DISCOLOURED WATER

Arabian Sea

s.s. *Orion*. Captain S. Ayles, R.D. Colombo to Bombay. Observers, Mr. P. J. Shepard, Junior 2nd Officer (first observation) and Mr. B. C. Holleyoak, Senior 3rd Officer (second observation).

16th October 1960, 0700 GMT. The vessel passed through frequent stretches of discoloured water, in the form of narrow dense white streaks about 200 yd. in length and lying in various directions. They seemed to be formed of a powder-like substance, very thick in places, floating entirely on the surface of the sea and not extending beneath it at all. Sea temp. 83°F; smooth sea; wind, light and variable, force 1.

Position of ship: 9° 16'N, 76° 10'E.

16th October 1960, 1300 GMT. The vessel passed through streaks of discoloured water for 4 hours previous to 1300. Also, several patches of phosphorescence were seen, apparently shoals of fish jumping in and out of the water. Sea temp. 84°F; smooth sea; wind, light and variable, force 1.

Position of ship: 11° 02'N, 75° 15'E.

s.s. *Helenus*. Captain M. J. Case. Singapore to Aden.

17th October 1960. Between 2145 and 2235 GMT, the vessel passed through great areas of plankton which lay in lines and patches as far as could be seen on either side of the ship. The lines were more or less parallel with the ship's course although joined at times by crossing lines and patches. The night was dark and clear (no moon or cloud) and there was marked phosphorescence in the bow wave and wake. Phosphorescence was not noted around the lines and patches of plankton which, however, could be seen at a reasonable distance from the ship, as they had the appearance of lightish stains upon the water.

On the previous evening when the vessel was nearing Point de Galle, Ceylon, a large school of whales had been sighted by various members of the crew.

Position of ship at 2200: 6° 53'N, 76° 58'E.

Note. Dr. T. J. Hart, of the National Institute of Oceanography, comments:

"Algal blooms of several types have been recorded from this area. If the one responsible for the discolorations reported by the *Orion* [see above] was one of those noxious to other forms of life, it might account for the foam and scum at the surface.

"Very dense plankton concentrations, including visible blooms of Flagellates, are known from the coast of India. The sample from the *Helenus*, was preserved with 5 drops of carbolic acid (not an ideal fixative, but it has prevented bacterial action) and suggests an extremely rich diatom plankton. The phosphorescence would certainly be due to something else,

probably dinoflagellates. We found off S.W. Africa that an abundant diatom plankton could co-exist with a dinoflagellate bloom, though the latter was probably noxious to animal plankton.

"The fact that the two reports from the *Orion*, some 100 miles apart, and that from the *Helenus* much farther south, were all made within two days, suggests very heavy plankton production all along the west coast of India during the preceding weeks, just prior to the seasonal shift in the monsoon."

Gulf of Panama

m.v. *Durham*. Captain R. G. Hollingdale. Bluff to Balboa. Observers, the Master and all officers.

5th March 1961. At 1000 GMT large areas of the sea were seen to be coloured blood-red, some being as much as a mile in diameter. A sample of the water taken when the vessel was in one of these patches did not appear to be noticeably red, but it had numerous very minute living creatures in it. These appeared to be of two types. One type was bright green in colour with large 'wings' longer than the body; the other resembled a minute shrimp and was almost transparent. An attempt was made to keep them alive, but they died within two days. At 1200: sea temp. 76°F; wind, light and variable; sea calm.

Position of ship: 6° 13'N, 80° 28'W.

Note. Discoloured water is usually associated with the prolific production of sea organisms caused by a local increase in available nutrients. Upwelling is a mechanism experienced in this area which could have caused this.

North Pacific Ocean

m.v. *Rangitata*. Captain A. Hocken. Wellington to Panama. Observer, Mr. C. C. Hufflett, 3rd Officer.

19th February 1961. At 2120 GMT the vessel entered a large patch of water about 6 cables by 6 cables in size, which was red in colour, the shade being similar to the red loam soil of Devon. It was estimated that the discoloration extended from the surface to a depth of 4 ft. The vessel's bow wave was, however, the normal colour and it was noticed that the substance causing the discoloration formed streaks, and whirls in the turbulent water, refusing to mix with it. Unlike all the previous cases of discoloured water which the observer had encountered, the line of demarcation was in this instance clear and distinct. The wind at the time was NE, force 2, and the discoloured sea looked sluggish as if it had been calmed by oil. Heavy current rips had been seen throughout the day and over the last 24 hours the set had been S 62° W at 1½ kt. The sea temperature remained constant at 78·4°F.

Position of ship: 4° 00'N, 81° 37'W.

Note. This observation is full of useful details, e.g. wind, current, etc., from an area of considerable oceanographic interest. It seems likely that the discoloration was due to upwelling, this being an area where upwelling is common.

SUBMARINE EARTHQUAKE

North Atlantic Ocean

s.s. *Garonne*. Captain L. C. Kingswood. Gibraltar to Portland (Maine). Observer, the Master.

31st January 1961. At 0100 GMT the ship took a heavy roll and suffered violent vibration for a few seconds, so much so that some of the complement were alarmed from their beds. The 2nd Officer called me and reported that he had the sensation that the ship was grounding, although the charted depth was about 1,100 fm. After reflection and discussion with the officers I could reach no satisfactory

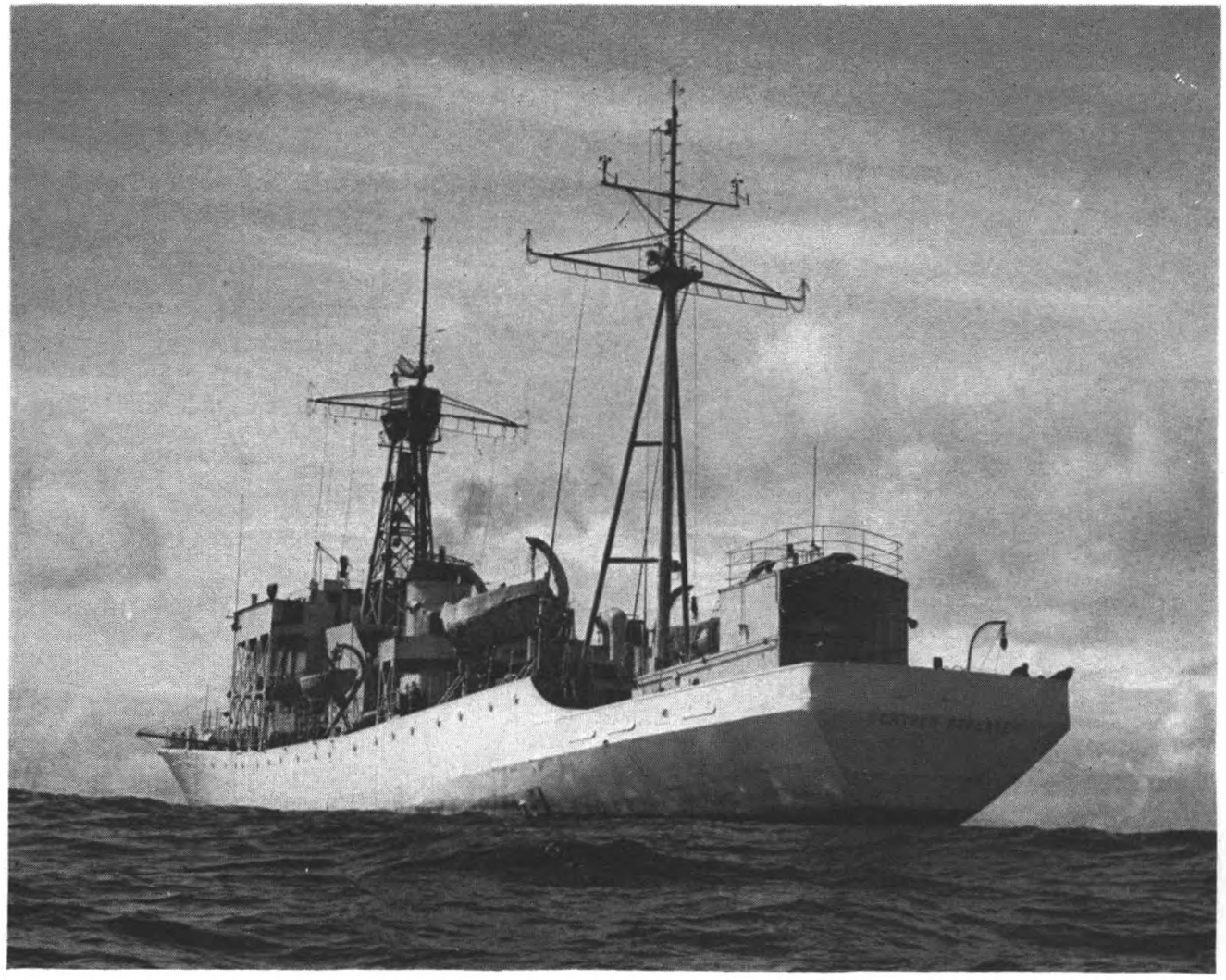


Photo by courtesy of R. Brass, Chief Radio Technician

An unusual view of O.W.S. *Weather Reporter* lying stopped at station 'I' in the North Atlantic (59°N, 19°W), from one of the ship's boats. The radar is shown tracking a balloon for an upper air ascent; the sounding boom is rigged for making a bathythermograph observation. Note the 'whip' aerial abreast the bridge and abaft the port lifeboat.

(*Opposite page* 16)

)pposite page 17)

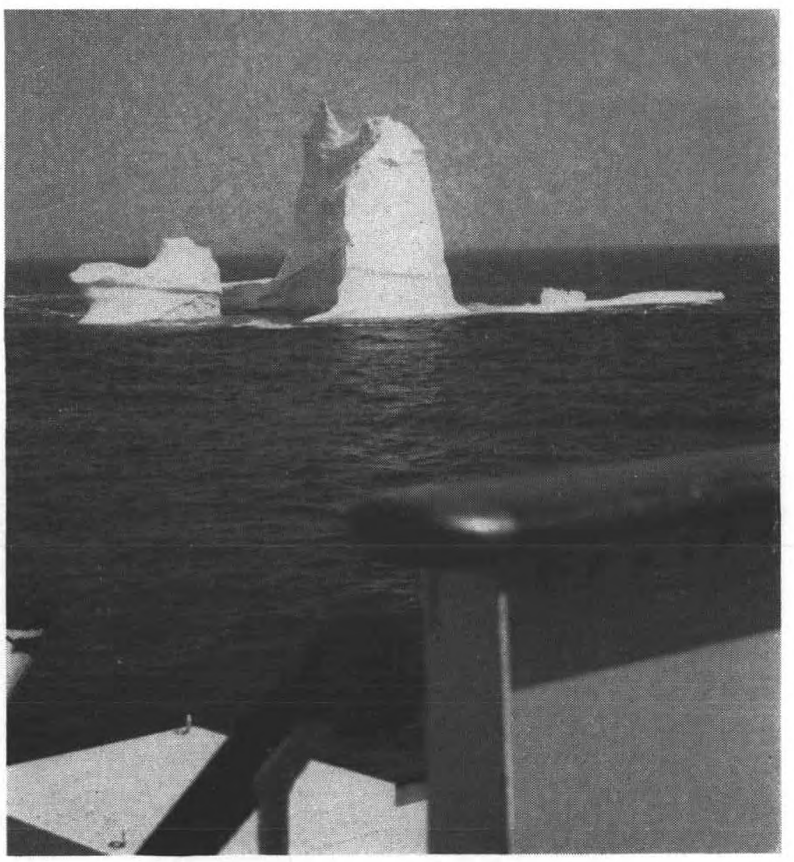
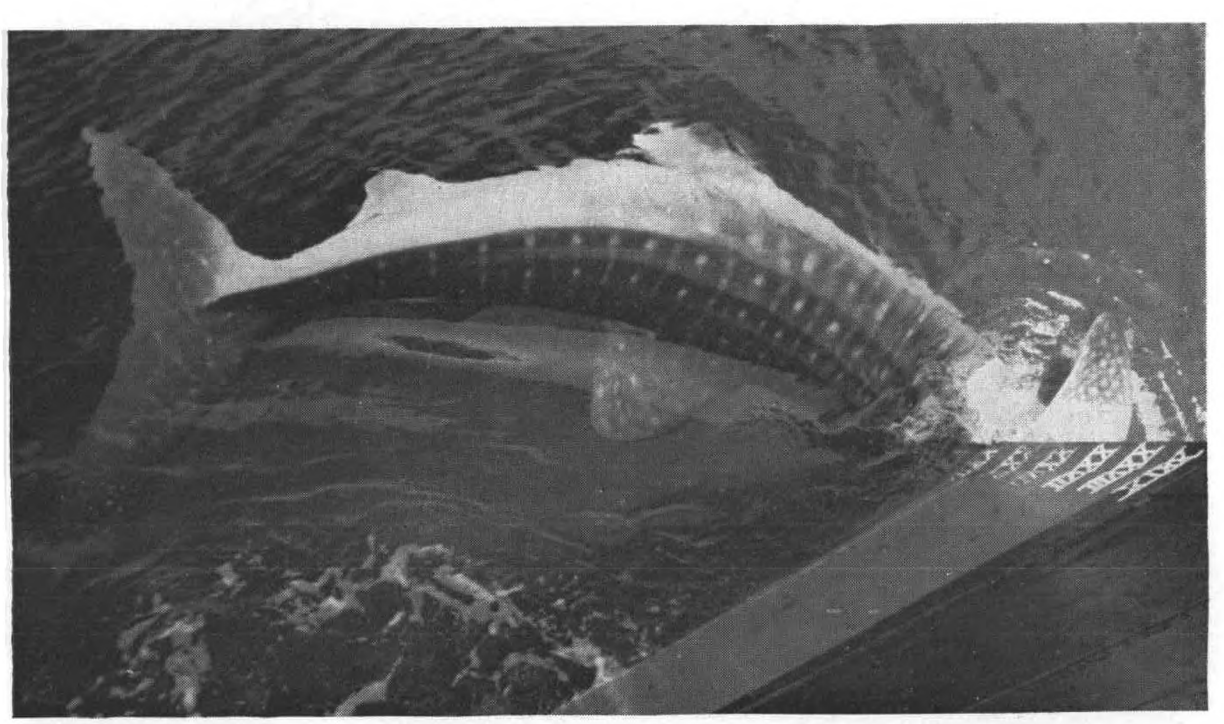


Photo by courtesy of J. B. Walker, Chief Officer

Iceberg observed by s.s. *Empress of England* (see page 17).



Whale shark observed by m.v. *Chindwara* (see page 17).

conclusion as to the cause of the disturbance. Wind WNW, force 6; moderate to rough sea with heavy swell.

Position of ship: 44° 27′N, 28° 15′W.

Note. Mr. J. Piegza, of the Seismological Department of Kew Observatory, comments:

"In our opinion this was caused by the so-called 'seaquake' which in reality is an ordinary tectonic earthquake but under the bottom of the sea. In such a case the elastic seismic waves are transmitted through the rock to the sea bottom and then up through the ocean as compressional water waves. When these waves hit the bottom of a ship they invariably cause the sensation of the vessel striking solid ground. They also may cause considerable rolling of the ship. All this, of course, will happen only when the vessel is in the vicinity of the epicentre.

"The ship was at the northern part of the mid-Atlantic ridge where small and moderate earthquakes are quite frequent."

ICEBERG

North Atlantic Ocean

s.s. *Empress of England.* Captain J. P. Dobson, D.S.C., R.D. Liverpool to Montreal via Belle Isle. Observer, Mr. J. B. Walker, Chief Officer.

20th June 1960. A large iceberg was sighted (see photograph on opposite page), 355 feet in height by sextant angle. It appeared to be grinding on the sea bottom, and ready to split in two.

Position of ship: 40 miles due E of Belle Isle.

Note. The great height of this berg suggests that there was a very large piece of ice below the surface, probably reaching down to the sea bed (depth about 700 ft.).

Ice charts for the period show numerous scattered bergs extending as far south as 46°N. Large numbers of bergs were obstructing the approaches to the Belle Isle Strait. Field-ice was below normal and during the latter part of June had dispersed rapidly from the Newfoundland area. This berg would probably have been within the pack-ice about a week before the photograph was taken.

WHALE SHARK

Arabian Sea

m.v. *Chindwara.* Captain M. H. Vincent. Mombasa to Aden. Observers, the entire ship's company.

4th November 1960. The very unusual photograph (on opposite page) shows a whale shark caught at 0430 GMT on the bow of the vessel as it was approaching Ras Hafun Lighthouse from the south at 14½ kt. The ship stopped and went astern, whereupon the shark sank, presumably dead after having been impaled for over 20 min. It was grey on the top, had a white mottled belly and measured some 33 ft. in length. Sea temp. 77°. Weather fine and sunny.

Position of ship: 10° 18′N, 51° 18′E.

Note. Mr. P. H. Greenwood, of the Fish Section at the Natural History Museum, comments:

"I was very interested to see this excellent photograph of a whale shark (*Rhincodon Typus*).

"Although not rare, whale sharks cannot be considered common. Records for these species are scattered throughout tropical seas; the nearest I can trace to Ras Hafun is from the Red Sea and the straits of Bab-el-Mendab. The most southerly record is from Cape Town (where incidentally the species was first found) and the most northerly, New York.

"The whale shark is the longest shark known, but is harmless to man. It feeds by straining out small planktonic animals from the water; the large and rather specialised gills are beautifully adapted for this purpose. Because of its sluggish ways and habit of moving slowly near the surface, this shark is not infrequently involved in collisions with ships.

"I should imagine that the fish was killed on impact, particularly since the ship was travelling at over 14 kt.

"The photograph clearly shows the chequer board and dot colour pattern which is characteristic of these species."

PHOSPHORESCENT ORGANISM

Arabian Sea

m.v. *British Patience*. Captain R. E. Bell. Umm Said to Kwinana. Observer, Mr. R. F. Millsom, 2nd Officer.

8th February 1961. A minute organism (1½ mm. × 1 mm.) was seen clinging to the outside of the sea temperature bucket and emitting a vivid blue glow. When examined through the 'wrong end' of prismatic binoculars, under strong electric light, an ovoid reddish brown patch on it was seen to be pulsating quite rapidly, but after about 5 min. the movement ceased, presumably due to the death of the creature. Shortly afterwards an ovoid green patch turned dark and the reddish brown patch became almost black. It was in a transparent shell, which was quite smooth and hard externally. Sea temp. 75°F.

Position of ship at 1800: 20° 36'N, 62° 00'E.

Note. This observation was forwarded with a sketch (not reproduced here) to Dr. T. J. Hart, of the National Institute of Oceanography, who comments:

"We cannot be sure from the description what the animal was. . . . Hundreds of different plankton animals in scores of groups have the power of luminescence, and unless we have the pickled (or living) specimen in front of us we cannot begin to identify them."

PHOSPHORESCENCE

Persian Gulf

s.s. *Caltex London*. Captain J. G. Smith. Suez to Bandar Mashur. Observers, Mr. P. Denham, 2nd Officer, Mr. C. d'Aguilar, 3rd Officer and Mr. W. P. Bilton, Junior Mate.

16th January 1961, 1730 GMT. The vessel was passing through normal phosphorescence visible in the bow wave and wake as a dull green colour. At intervals areas of sea were traversed where the water sparkled with thousands of spots of brilliant phosphorescence about the size of a penny. During these periods the bow wave emitted an extremely bright emerald green light sufficiently intense to illuminate the mast, rigging, etc.

At 2145 the vessel passed through the first of many bright bands of phosphorescence which, when seen at a distance through binoculars, seemed to be off-white in colour, but which on closer examination were found to consist of numerous spots of phosphorescence, some a foot in diameter. The bands lay in directions varying from 240° to 280° with widths ranging from 20 to 50 ft. and stretching, in some cases, as far as the eye could see. The bow waves of passing ships could be seen up to a distance of 6 miles, when binoculars were used. It was interesting to note that there was no reaction from the phosphorescence when the Aldis lamp was shone on to the water. Samples of sea water were taken which contained the

two types of transparent white cells shown in the accompanying diagram. Each was $\frac{1}{32}$ in. approx. in diameter. Sea temp. 71·6° to 72°F; sea calm; wind light and variable; no cloud.

Position of ship at 2145: 26° 23'N, 54° 11'E.

Indian Ocean

s.s. *Amra*. Captain N. C. Bruce. Mombasa to Bombay. Observers, Mr. A. M. Barker, 2nd Officer and Mr. J. G. Mackechnie, 2nd Radio Officer.

11th March 1961. At 2030 GMT a few patches of phosphorescence about the size of small jellyfish were seen close around the ship. Having recently read the account of the *Monmouthshire's* experiment in the October 1960 issue of *The Marine*

Observer, we decided to try the same, with excellent results. Movement of the Aldis lamp in lines along the surface produced almost instantaneous reaction, the area becoming a brilliant green as the light was swung. The luminescence lasted between 20 and 30 sec. after the Aldis was removed; the time depended upon the distance of the phosphorescent patches from the ship and this sometimes was at least 2 cables. Without the stimulus of artificial light no phosphorescence was seen.

At the same time another type of phosphorescence, of very different appearance, was observed. This, like the other, only responded to artificial light and it took the form of a pin point of light exactly like a lighted cigarette. The pin points occurred singly and were sparse, there being about one per 400 sq. ft. of surface. They did not appear, apart from one or two occasions, to be under the water but were very definitely floating on the surface and apparently disturbed by the wind; they seemed to be in no way connected with flying fish. The points of light disappeared instantly when the Aldis was switched off, and sometimes they seemed to 'burn out' even with the lamp still on. No phosphorescence was seen after 2359. Sea temp. 83°. Sea slight with low swell. Gentle breeze. Weather fine.

Position of ship: 4° 30′N, 50° 00′E.

South Pacific Ocean

s.s. *Kenuta*. Captain D. I. Jones. Antofagasta to Matararu (Peru). Observer, Mr. J. Scott, 3rd Officer.

21st December 1960, between 0100 and 0200 GMT. Bands of phosphorescence, apparently stationary, were seen, having the form shown in the accompanying

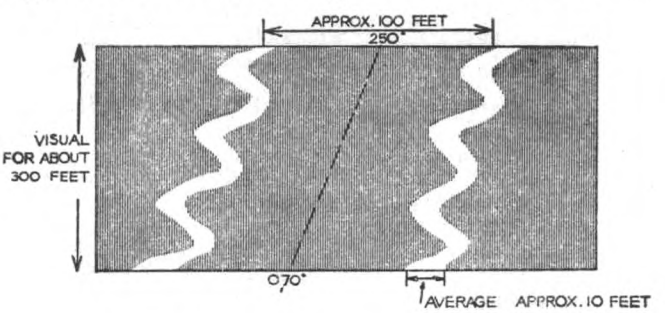


diagram. They occurred in groups, and in every case there were two separate and distinct bands about 10 ft. wide, each following the contours of the other, and about 100 ft. apart. They were at least 300 ft. in length, but how much more could not be determined, as beyond this distance they were out of visual range. The bands were orientated 070°–250°. After 0200 they became scattered and had no definite pattern, but their width still remained at about 10 ft. Apart from the bands, no other phosphorescence of any kind was seen. The weather was overcast and the sea smooth. Sea temp. 77°; wind calm; visibility very good.

Position of ship at 0100: 19° 02′S, 71° 43′W.

ODOUR FROM GUM TREES

South Pacific Ocean

m.v. *Durham*. Captain R. G. Hollingdale. Geelong to Auckland. Observers, the Master, Mr. G. F. Morris, 3rd Officer and the Watch.

13th January 1961. At 2030 GMT, when the nearest part of New Zealand was 110 miles away, on a bearing of 090°, a strong smell of gum trees was noticed. The wind was ESE, force 6–7. Air temp. 63°F, wet bulb 62°, sea 66°. Rain fell at intervals throughout the day.

Position of ship: 34° 52′S, 169° 24′E.

Note. Dr. G. Taylor, Director of the Royal Botanic Gardens at Kew, comments:

"The eucalypts are not natives of New Zealand but they have been fairly widely planted

there. On a warm day the odour of the trees saturates the air and given the conditions of a steady breeze without much turbulence the smell could be carried far out to sea. It is interesting to have direct evidence of such an occurrence."

HALO COMPLEX

Mediterranean Sea

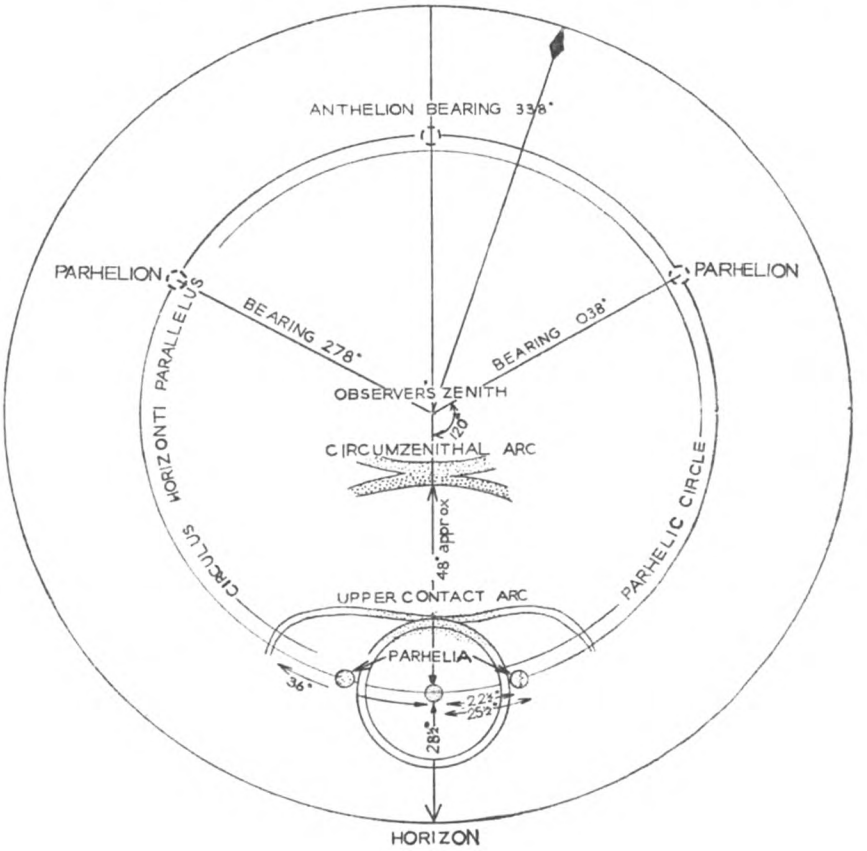
s.s. *Kent*. Captain P. P. O. Harrison. Observers, the Master, Mr. G. McCathie, Chief Officer, Mr. E. Jones, Supernumerary Chief Officer, Mr. D. Pomphery, 2nd Officer, Mr. W. Carver, Supernumerary 2nd Officer and Mr. J. Gill, 3rd Officer.

20th January 1961. At 1010 GMT, when the sun's altitude was 28½°, a halo of 22° radius was seen, with two parhelia each 25° from the sun (Fig. 1). The upper arc of contact was in the shape of inverted horns, bent downwards and terminating on the parhelic circle (which was complete) at a position 36° on each side of the sun. Below the lowest part of the 22° halo, there was a very bright, rather yellowish light. The upper part of the 46° halo (measured as 48°) was present, exhibiting reddish-brown coloration. Part of the circumzenithal arc, which was pale green above and pale red below, was seen. The two 120° parhelia and the anthelion were observed, both being very white and distinct.

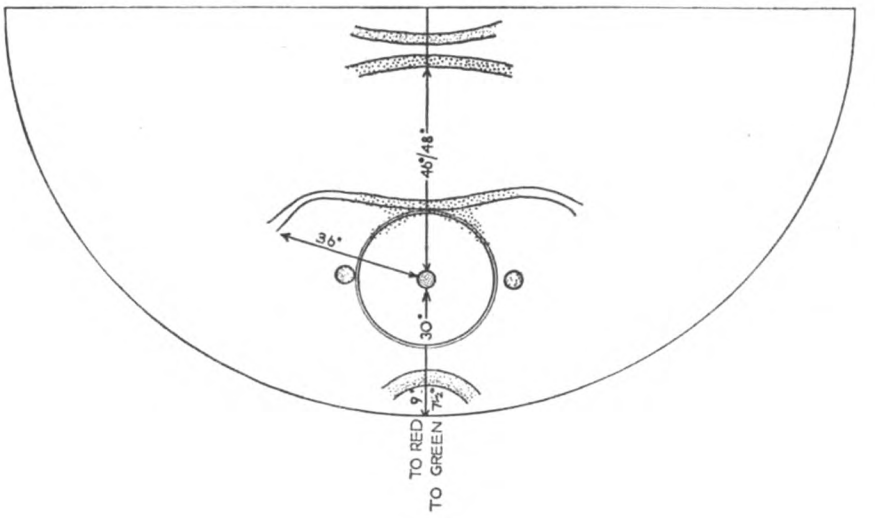
By 1035, when the sun's altitude was 30°, the parhelic circle, the anthelion and the two 120° parhelia were gone; the rest of the complex remained and in addition an arc had appeared at the bottom of the 22° halo (Fig. 2). This showed bright red and green coloration: the light between this arc and the 22° halo had become intensified and showed pale green and pale red.

At 1045, some thirty degrees of arc of the 46° (or 48°) halo appeared at the left of the sun: it showed bright green and red coloration (Fig. 3). All the phenomena seen at 1035 were also present.

Shortly afterwards everything disappeared except the 22° halo and the parhelia,



(1)



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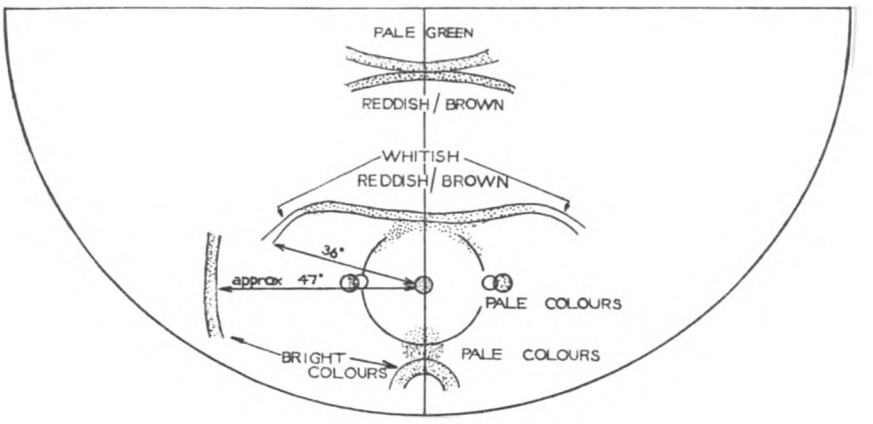


(3)

which continued to be seen intermittently. Air temp. 58°F, sea 57°; barometer 1026 mb.; 8/8 Cs. and some Cu.

Position of ship: 37° 29′N, 7° 36′E.

Note. We are grateful for this very full description of a halo complex. Unusually distributed and oriented crystals, refraction and diffraction were probably needed to produce the colours and rare-shaped halo arcs. It is of interest to note the unusual colour of the 46° halo and the shape of the upper arc of contact of the 22° halo. The coloured arc below the 22° halo is of particular interest.

LUNAR HALO

North Atlantic Ocean

m.v. *Durango*. Captain R. C. S. Woolley, R.D. London to South America. Observer, Mr. D. Phillips, 4th Officer.

9th January 1961. Between 0400 and 0500 GMT a complete 46° halo, rather off-white in colour, was seen round the moon, then 22 days old. About 0510 the halo appeared to decrease in size, becoming one of 22° radius. After approx. 10 min. it changed back again to its previous size of 46° radius. The cloud inside the halo could not be seen but it was visible around the outside of the circle. At 0615 cloud prevented further observation. Air temp. 62°F, wet bulb 59°; visibility very good; wind ENE, force 2; cloud, Cs. and 3/8 Cu.

Position of ship at 0600: 29° 30′N, 14° 30′W.

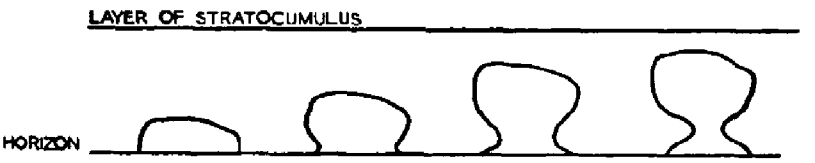
Note. This observation is both rare and difficult to explain. The 22° halo is produced by refraction in hexagonal ice crystals and the 46° halo by refraction in 90° ice prisms. Both refractions are possible from the same crystals, and it is possible for one halo to develop while the other fades.

ABNORMAL REFRACTION

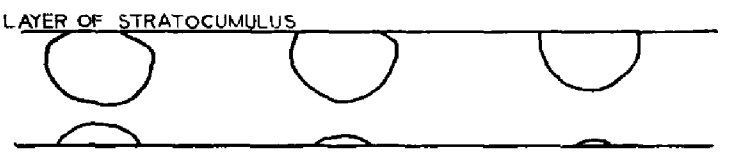
North Pacific Ocean

m.v. *Glenorchy*. Captain J. B. Anderson. Hong Kong to Yokohama. Observers, Mr. N. P. Austin, 3rd Officer and Midshipman M. Edward.

8th January 1961. When the moon was rising at 1340 GMT it was a bright pink colour, and at first sight of normal shape, but in the course of the next 2 min. it underwent the changes shown below. The illusion observed was that a second



moon was merged into the true one and rising with it. Careful observation through binoculars then showed that the real moon was rising at a greater rate than the image beneath it: the connection between the two narrowed and then parted. The upper part of the moon was then passing behind a layer of Sc. close to the horizon,



and as it continued to do so the image set below the horizon. Air temp. 51·5°F, wet bulb 46°, sea 63°. Wind E, force 1. 2/8 Sc. was present at the time, but a thin layer of St. soon covered the sky.

Position of ship: 33° 16′N, 137° 19′E.

Note. This spectacular display of abnormal refraction of light from the moon is typical of the passage of light through air over a warmer sea.

Investigator's Strait

s.s. *Hemiglypta*. Captain E. L. Petherbridge. Port Adelaide to Kwinana (Fremantle). Observer, Mr. G. A. Master, 2nd Officer.

21st January 1961. Between noon and 1500 LMT conditions of abnormal refraction were observed. At times the entire Strait appeared to be completely landlocked; the entrances of Spencer Gulf, Gulf of St. Vincent and Backstairs Passage were not sighted until they were at their points of closest approach. All the land appeared as a 'table top' and only at intervals could it be recognised, inversion making navigation very difficult. The tanker *Clyde Inventor* suffered inversion periodically and was last seen steaming upside down in our wake! The land image over the entrance to the Strait appeared to be a shimmering mass and at times bore a resemblance to the land astern of us, the Fleurieu Peninsula. All the phenomena disappeared with the onset of a strong SW'ly breeze and a fall in temperature of 4°F, but a certain amount of haze was then seen. Air temp. 79°F, wet bulb 70°, sea 71°; no cloud.

Position of ship at 0600 GMT: 35° 24′S, 137° 00′E.

Note. These phenomena were probably associated with warm, dry air of land origin flowing over the cool sea.

GREEN FLASH AT SETTING OF VENUS

Arabian Sea

m.v. *Egidia*. Captain A. J. Colquhoun. Karachi to Aden.

9th February 1961. On setting at 1733 GMT, Venus turned a bright "side-light" green just as it dipped below the horizon. From the time that it was 20° above

the horizon until it set, the planet was frequently a light red colour. Air temp. 75°F, wet bulb 68°, sea 77°; wind NE, force 2; no cloud; visibility very good: sea calm.

Position of ship: 16° 30′N, 54° 48′E.

AURORA

Date	Ship	Geographic Position		Λ	Φ	I	Time (GMT)	Forms
2nd Oct. 1960	*Swiftpool*	49°20′N	65–66°W	360	61	+75	2300–0400	L, HA, R
6th	*Logna*	61°08′N	00°13′W	090	63	+73	1900–2015	RB, R, C
7th	*Logna*	60°19′N	02°11′W	090	63	+73	0400–0410	R, P
	Manchester Merchant	49°54′N	43°10′W	030	60	+71	0105–0110	R, F
18th	*Inishowen Head*	54°18′N	45°24′W	030	64	+73	0220–0223	G, R
24th	*Otra*	61°50′N	02°25′E	090	63	+74	1900–2100	G, HA, RA, R, P
25th	*Port Pirie*	52°02′N	04°00′E	090	54	+68	2200	G
	Parthia	52°42′N	35°48′W	040	61	+71	2300–2315	RA, R
12th Nov.	*Edenmore*	68°00′N	15°00′E	110	66	+76	1600–2300	All forms
	Bravo	53°30′N	00°30′E	080	56	+69	2149	HA
	Gloucester City	57°30′N	10°00′W	080	56	+68	2130–0010	HA, RB, R, S
	Himalaya	50°45′N	00°15′E	080	53	+66	2200–0120	G, R
13th	*Port Adelaide*	52°24′N	28°24′W	050	60	+69	0400–0700	DR, R
	Cape Franklin	47°37′N	52°57′W	020	58	+72	0100–0500	G, P
	Trelissick	44°26′N	141°33′W	280	47	+63	0630–1345	G, HA, RA, R
	Edenmore	68°00′N	15°00′E	110	66	+76	—	All forms
	Hinakura	23°55′N	48°48′W	020	35	+54	0030–0500	G
15th	*Edenmore*	68°00′N	15°00′E	110	66	+76	—	L
18th	*Port Adelaide*	41°24′N	63°12′W	010	53	+72	0500–0700	G
9th Dec.	*Logna*	60°24′N	04°42′E	100	61	+72	2215–2345	HA, RA
16th	*Port Wyndham*	34°06′S	101°12′E	170	−45	−69	1840–1910	G, RB, R
8th Jan. 1961	*Weather Adviser*	64°06′N	22°48′W	070	70	+75	0245, 0545	DR
	Weather Adviser	63°00′N	28°12′W	060	70	+76	1900–2345	HB, RB
9th	*Weather Adviser*	62°00′N	32°42′W	060	70	+76	2245	DR, P
	Weather Reporter	58°54′N	19°17′W	070	65	+73	0001	G
							2100–2400	G, HA, HB
10th	*Weather Reporter*	58°54′N	19°17′W	070	65	+73	0600	G
13th	*Hertford*	23°00′N	74°30′W	350	34	+57	0945	R
	Weather Adviser	61°51′N	33°26′W	050	70	+76	2330	HA
15th	*Silvercrag*	51°31′N	33°00′W	050	60	+70	0100–0400	G
	Truro	57°48′N	08°00′E	100	58	+70	2145	L
16th	*Weather Reporter*	59°12′N	18°57′W	070	65	+73	2100	L
18th	*Weather Reporter*	58°47′N	18°55′W	070	65	+73	0600	G
							2100–2400	G, R
	Weather Recorder	59°33′N	14°00′W	070	64	+73	2100–0300	G
19th	*Weather Reporter*	58°51′N	18°51′W	070	65	+73	0001–0300, and 0600	G, R
							2100–0300	G, HA
	Weather Recorder	62°20′N	19°30′W	070	68	+74	1800, 2000	G, HB, P
21st	*Weather Recorder*	63°48′N	23°24′W	070	69	+76	0600	R
22nd	*Weather Recorder*	62°45′N	29°40′W	070	70	+76	0720	R
23rd	*Weather Recorder*	62°17′N	32°00′W	060	70	+76	0300	G, S, P
24th	*Weather Recorder*	62°27′N	32°38′W	060	70	+76	0405	RA, R
26th	*Weather Reporter*	58°57′N	18°52′W	070	65	+73	0300	G
28th	*Weather Recorder*	61°51′N	33°30′W	050	70	+76	0900	G
4th Feb.	*Bravo*	56°32′N	05°38′E	090	58	+71	1815–2000	G, S, R, P
	Laksa	57°20′N	00°00′	090	60	+71	2240–2250	G, RB, C
5th	*Weather Recorder*	62°12′N	34°30′W	050	71	+77	0130, 0205, 0305	L
6th	*Weather Watcher*	58°55′N	19°36′W	070	65	+73	2400	G
7th	*Weather Recorder*	61°40′N	33°00′W	050	70	+76	0115	R, F
	Weather Watcher	59°10′N	19°40′W	070	65	+73	2145–2215	RB, R, P
9th	*Weather Watcher*	59°10′N	19°40′W	070	65	+73	2400	G
10th	*Weather Watcher*	59°10′N	19°40′W	070	65	+73	2400	G
11th	*Weather Recorder*	62°20′N	30°50′W	060	70	+76	0001–0315	All forms
							2050	R
12th	*Weather Recorder*	62°04′N	31°30′W	060	70	+76	0235–0245	R
							2250–2345	G, RA, R
13th	*Araluen*	38°27′S	148°07′E	220	−47	−68	1240–1321	G, R, P
	Weather Watcher	58°52′N	18°37′W	070	65	+73	2235	G, R, P
							2400	HA
14th	*Weather Recorder*	61°00′N	31°00′W	060	70	+75	0200–0210	RA, R
15th	*Weather Watcher*	59°10′N	18°30′W	070	65	+73	0300	G
16th	*Durham*	48°00′S	176°10′W	270	−50	−69	1000	HA
	Weather Watcher	59°30′N	19°30′W	070	65	+73	2338–2347	G
17th	*Gothic*	41°24′S	176°42′E	250	−45	−65	1150–1200	G, R
	Weather Recorder	56°44′N	11°18′W	080	61	+70	2100	G
	Rialto	52°42′N	35°30′W	040	61	+71	2140–2220	R, S
	Weather Watcher	58°59′N	19°13′W	070	65	+73	2338	G, R
18th	*Weather Watcher*	58°59′N	19°13′W	070	65	+73	0020–0600	RB, R, P
20th	*Weather Watcher*	59°10′N	19°10′W	070	65	+73	0001–0600	G, RB, R
							2100	G

The following notes and preceding table have been received from Mr. James Paton, of the Aurora Survey:

Auroral observations from ships for the three months 1st January to 31st March 1961 are shown in the accompanying table compiled by Mrs. Mary Hallissey at the Balfour Stewart Auroral Laboratory of the University of Edinburgh. (So far no observations have been received for March.) Also included in the list are observations made during the previous three months which have been received since the last issue of *The Marine Observer* went to press. Many of these are for the extensive displays between November 12th and 16th, mentioned in the October issue, and for which a considerable number of reports and sketches have been received.

Noctilucent clouds were again seen by observers in s.s. *Lismoria* on 26th June 1961 from a position south of Newfoundland; a valuable report of these rare clouds had previously been received from s.s. *Lismoria* in July 1959.

We should like to stress again how important it is for us to receive as many reports as possible so that when the details are charted with data from land and air observers, the extent and development of displays may be clearly seen. We are most grateful to all who send us information and for the helpful sketches which often accompany reports.

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Unsolved Problems of Weather and Climate

By R. C. SUTCLIFFE, C.B., O.B.E., B.SC., PH.D., F.R.S.
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The study of weather and climate is the science of meteorology, but not by any means the whole of that science. Meteorology is the study of the earth's atmosphere in all its aspects: its composition and its chemistry; its radioactivity, natural and man-made; the pollution of the air from houses and factories, and how this accumulates, travels and in time disperses; the transmission of sound through the air and the transmission of all kinds of electromagnetic radiation, from the ultra-violet, the visible and the infra-red through the spectrum to radio wave-lengths; and the special phenomena of radar and radio reflections from clouds and precipitation.

The science of meteorology also includes the study of a multitude of optical effects—sky colours, haloes and coronae, scattering, refraction, diffraction, etc.; electrical phenomena—not only the spectacular lightning but the remarkable potential gradients and electric currents revealed by instruments in apparently quite tranquil weather; and, of course, the special behaviour of the high atmosphere—for example, the photochemical effects that produce a protective screen of ozone at about 15 miles overhead and all the ionisation, auroral, magnetic, and electromagnetic effects which have long been of deep concern to radio engineers and have now become the pursuit of those who make use of the new vehicles, rockets, and artificial satellites. As one goes up higher, meteorology finally merges into the realms of space science.

Since the atmosphere is continuous, with its physical properties so interlinked, most if not all of these more recondite parts of meteorology have a bearing on weather and climate, either directly in cause-and-effect relationships or indirectly as the means for obtaining useful information. There is thus no essential difference between the complete meteorologist and the complete weatherman, but I would like to give attention here to those problems which are obvious and important to every inhabitant of our planet.

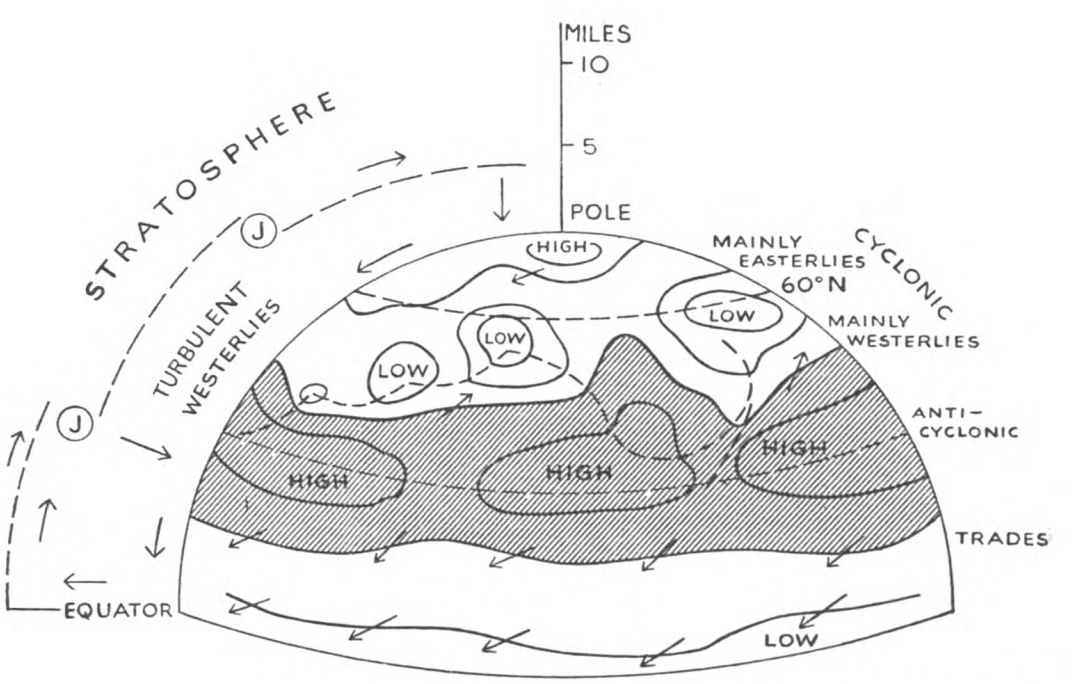
Naturally I shall not catalogue all the meteorological fauna but shall pick out a few important animals which dominate the population. First, there is the general circulation of the earth's atmosphere as a whole, the winds and weather experienced on our planet on the broadest possible scale. Second, we must mention the monsoons, a word which in technical usage means the varying large-scale circulations

from summer to winter or from season to season, not only in India but over much of the earth. Third will come the familiar depressions and anticyclones of our daily weather map; next the fierce cyclones or hurricanes of the tropical oceans which are responsible for untold damage and the grievous loss of life every year; and finally, showers and thunderstorms responsible for much heavy rain and destructive hail. A brief description of each of these as illuminated by recent research work will show where some of our greatest difficulties lie.

General circulation

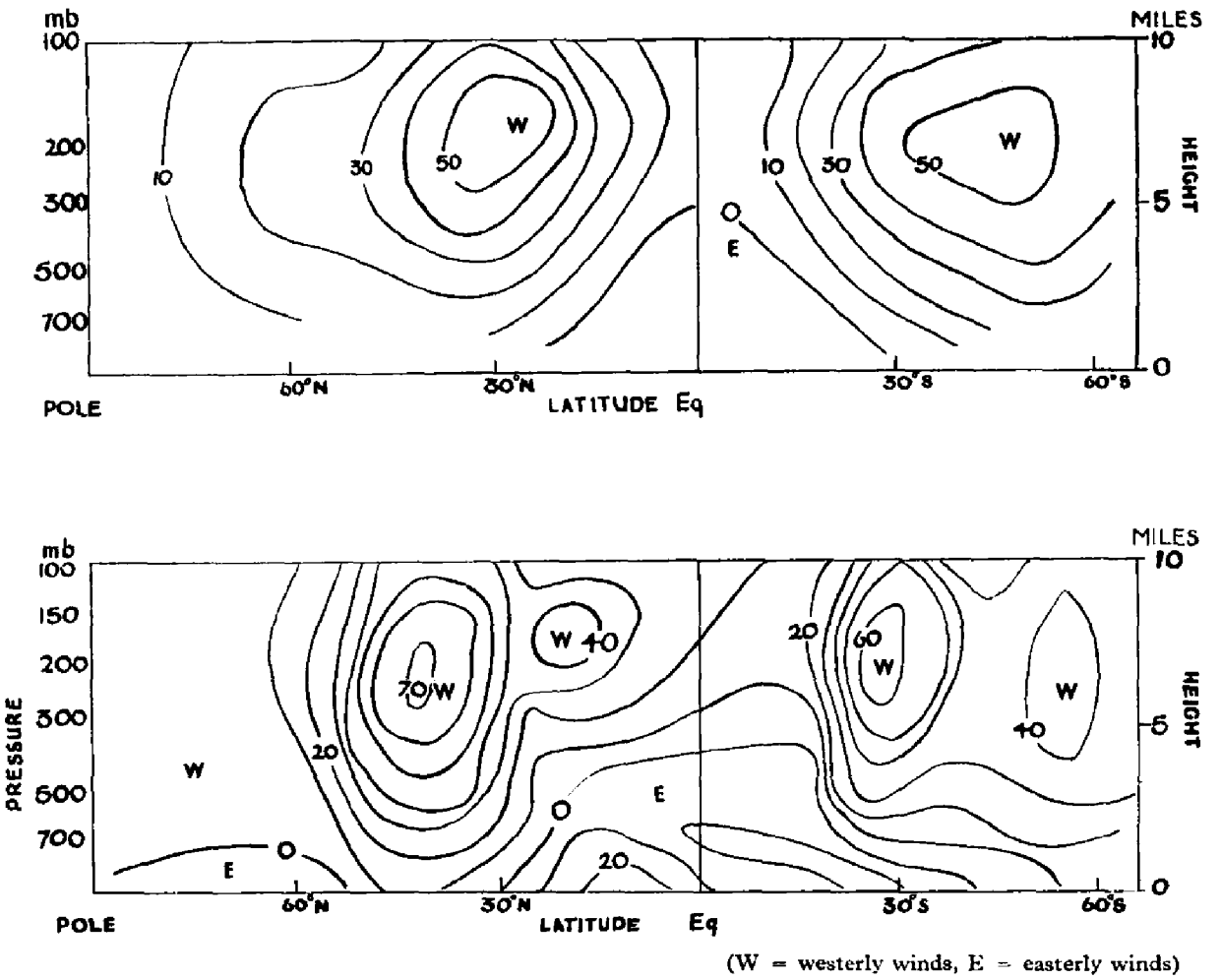
If we look at our problem on the broadest possible scale—as it might be from another planet—we see a spherical shell of mixed gases held to the surface of Earth by gravity, showing complicated convective motions under the variable heating from the sun and, because it overlies a water surface, carrying a variable amount of water vapour that is continuously replenished by evaporation and deposited elsewhere as rain or snow. The motions are certainly complicated, but when local features are smoothed out and averages are taken, a very remarkable world organisation is revealed, and this we call the general circulation. Some of the picture was known in ancient times and the broad outline of prevailing surface winds was filled in when ships began to circumnavigate the world. In recent times the wide use of sounding balloons has given a good three-dimensional world picture through the whole troposphere and far into the stratosphere, and very recent work with rockets has taken the record to much greater heights, even to the fringe of the atmosphere.

Figs. 1 and 2 show the structure of the general circulation as it is known at present. In the region of the turbulent westerlies (Fig. 1) the direction of mean circulation is uncertain. The most remarkable features—charted only in the last decade and not yet fully explored—are perhaps the jet streams, the cores of strong wind which encircle the earth just below the tropopause. It has now become clear that at any one time there are numerous minor and limited jet streams associated with minor fronts but sub-tropical and polar-front jet streams are almost always present and showing in the averages. There are two distinct tropospheric maxima in each



(The vertical scale is expanded about 100 times)

Fig. 1. General circulation of the atmosphere in the northern hemisphere. The tropopauses are shown by broken lines; the regions of maximum westerly winds in the upper air—the cores of the jet-streams—are indicated by the letter 'J'.



(W = westerly winds, E = easterly winds)

Fig. 2. North-south sections through the atmosphere showing the strength of the westerly winds (kt.) and the jet-stream centres. Upper diagram: average for world. Lower diagram: average for April at 180° longitude.

hemisphere. In addition there is a westerly jet stream high up in the winter stratosphere, but this is only indirectly linked with weather.

The exploration of the atmosphere everywhere with the discovery and charting of new and generally unexpected features has a fascination of its own for any true man of the weather, but the scientist must also ask deeper questions. Broadly speaking, the circulation at the present time is the same as it was a year ago; as much heat has been gained as lost, as much water evaporated as precipitated, and as much angular momentum passed to the earth below by friction as has been taken from it elsewhere, for the atmosphere is neither warmer, nor wetter, nor faster-flowing than it was before. We have, in other words, a state of balance, a steady state, and a full understanding must allow us to say how the steady state is maintained, where and how the heat or moisture or momentum is put in, where and how it is lost and what the mechanism is which transports properties from one place to another to redress any local unbalance. A full scientific understanding will, of course, need to represent all these processes by mathematical equations and the solutions of the equations will then be a fundamental theory of the general circulation and a first step in the theory of climate.

It can be categorically stated that, while innumerable text-books give more or less plausible explanations of the general circulation, there is not one which contains a basic theory although, of course, this does not imply that the explanations are entirely worthless. Indeed, a great deal has been added to our knowledge of the mechanism since Jeffreys (now Sir Harold) and others proved some thirty-five years ago that the average circulation can be explained only if account is taken of

the fluctuations as well. It is impossible to explain the distribution of energy, moisture, and momentum of the general circulation without taking account of the relatively smaller scale motions, just as it is impossible to explain the dispersal of smoke from a chimney without taking account of the small-scale turbulence in the air; for this reason, the depressions and anticyclones and other passing weather systems are often described as 'synoptic turbulence' in the general circulation. If, then, anyone purports to show why we have doldrums, trades, and brave west winds and makes no reference to turbulent irregular motions, we may be sure that he is guilty of sleight of hand and needs to be watched very closely.

This problem of providing a basic theory of the general circulation is very properly regarded as the most important of meteorology and there is every reason to believe that it can be solved in a matter of years if a sufficient number of able people can be wooed away from the blandishments of atomic nuclei and cosmic space. Important first steps have already been taken, especially by American workers, Phillips and Smagorinsky in particular, but the physics is complicated, the mathematics tough and the arithmetic taxing for even the most up-to-date electronic computers.

Monsoons

The word 'monsoon'—derived from the Arabic word for 'season' and originally used for seasonal winds in the Arabian sea—has been found convenient as a general term for large-scale seasonal variations. It has even been applied to the winds in the high stratosphere which circulate from west to east in the winter hemisphere and east to west in the summer, but these are planetary circulations caused by the fact that the summer polar stratosphere in continuous sunshine is warm while the winter polar stratosphere in continuous darkness is very cold. Many meteorologists would like to reserve the word monsoon for the seasonal changes of a geographical character caused by the differences in thermal properties between continents and oceans.

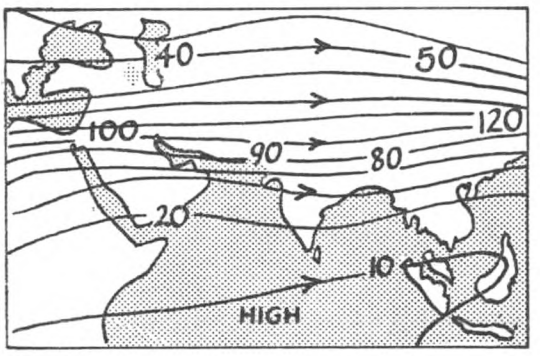
The basic causes for all these seasonal changes are similar. For all ordinary meteorological purposes, the atmospheric pressure is hydrostatic and differences of temperature (or density) imply differences in the pressure. The first intuitive argument is that warm air, being less dense, will give a lower pressure at the earth's surface than cold air, but this is no more than half the story. By working hydrostatically from the bottom upwards, we could equally well say that warm air will give high pressure above and cold air low pressure above, since in hydrostatics density is linked not directly with pressure but only with the change of pressure with height. Misunderstanding on this simple matter has led to much fallacious argument in meteorology, although there would seem to be no excuse when it is so well known that the surface pressure in the warm air over the tropical oceans is generally higher than that in the cold air of the polar seas. The distribution of pressure in the atmosphere presents, of course, a dynamical problem for which the hydrostatic decrease of pressure with height is only one of the conditions to be satisfied; as a matter of fact, it is more generally true to associate high temperature with high pressure aloft than with low pressure below. It is as a consequence of this that upper winds in the troposphere (including the jet streams) are generally from the west, circulating cyclonically round the areas of low upper-air-pressure in the colder regions nearer the pole.

Coming now to monsoon circulations, we need to explain how the winds are produced by the seasonal change in the differences in temperature between land and sea. Comparatively, the oceans change little in temperature through the year for the extra sunshine of summer is stored within a considerable layer of surface waters. Over the land, the summer heat is not stored but is given off very readily to the air with the result that, in relative terms, air over the land is warm in summer and cold in winter. The effect hydrostatically is for summer to have either low

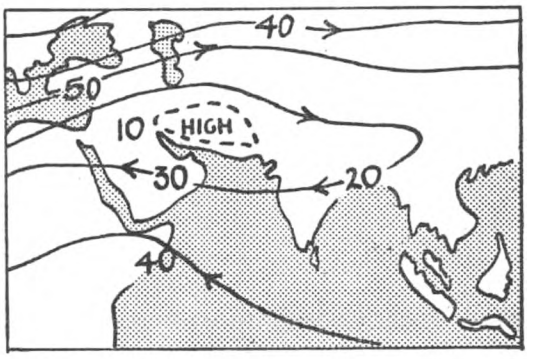
surface pressure or high upper air pressure, and when the dynamics of winds is introduced the solution is a compromise; both low surface pressure and high upper air pressure are found centred over the hot part of the continent. This arrangement permits the low surface air to converge and the upper air to diverge, giving a satisfactory dynamical model. It is extremely interesting to study the circulation of the Indian summer monsoon in this light and diagrams are given showing the flow at the surface and at 200 millibars (a height of about 40,000 ft. under average conditions) in winter and summer (Figs. 3 and 4). The strong

January, surface.

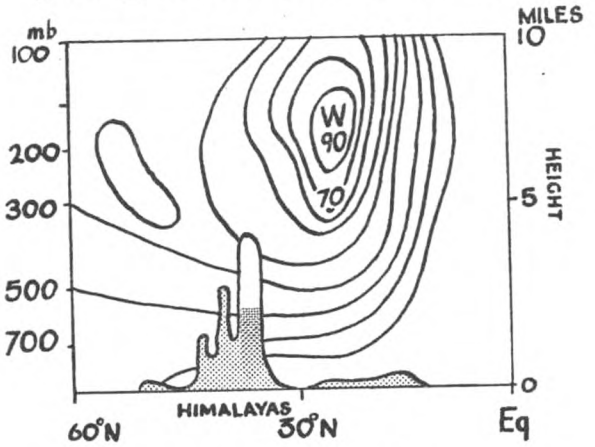
July, surface.



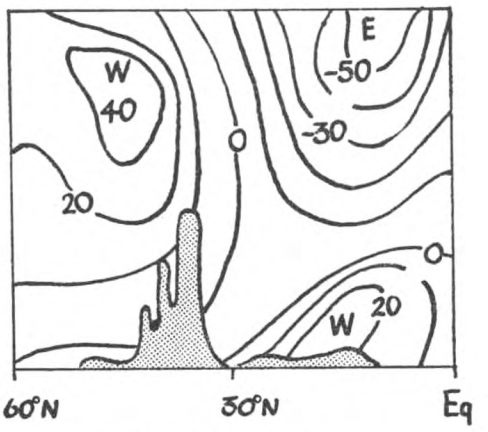
January, 200 mb. (about 40,000 ft.).



July, 200 mb.



January, N–S section.



July, N–S section.

Fig. 3. Monsoons in three dimensions. The charts for January and July show the difference in wind regime from winter to summer. The surface charts show the familiar monsoon winds near the ground with a complete reversal over the Indian Ocean and its neighbourhood. At about 40,000 ft. above there is a change from a strong westerly, 100 kt. near the jet stream, to an easterly wind over India at the time when the SW monsoon is blowing at the surface. The N–S sections show the jet-stream core very clearly. In winter it is south of the Himalayas but in summer the westerlies are north of the mountains, with an easterly jet stream to the south. Note how the upper-level easterly jet stream is found high up above the low-level westerlies.

Numbers show mean wind speed in kt.

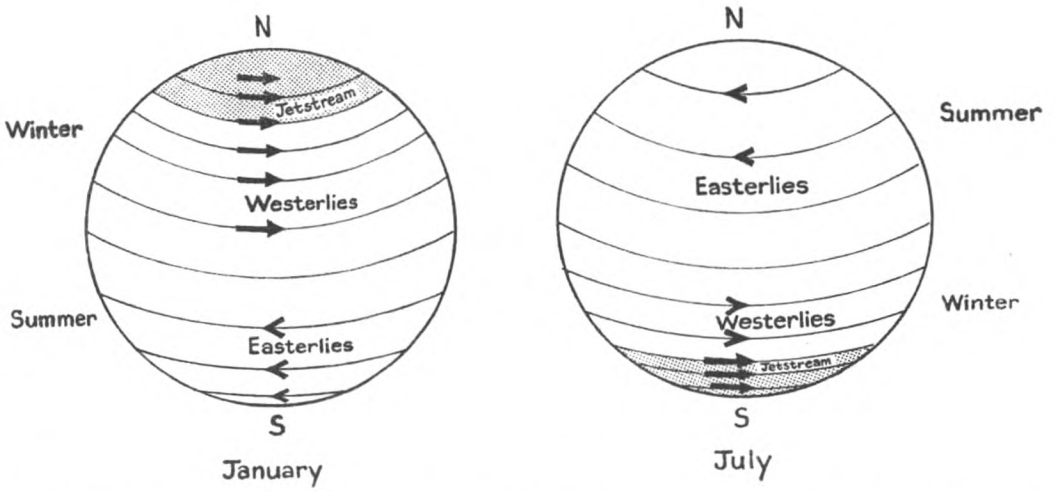


Fig. 4. Monsoons in the stratosphere. At high levels, 20 to 35 miles above the earth, there is a complete change from season to season with westerly winds in the winter hemisphere and easterly winds in the summer hemisphere. Near the edge of the polar winter darkness a stratospheric jet stream develops and disappears suddenly in the spring, with sudden warming of the stratosphere.

easterly winds of summer at high levels over Aden are as genuinely monsoonal as are the south-westerly surface winds over India itself. Sections taken roughly north to south through Aden in April (not illustrated here) fully show the quite remarkable nature of the change, the easterly upper winds of July having a jet stream structure.

The monsoon changes over the world are a representation of the annual rhythm of weather and have far-reaching consequences for some regions, including north-west Europe, which may seem to be beyond their influence. Year differs from year and the onset of the Asiatic summer monsoon, whether dated from some criterion of Indian weather or dated from the onset of east winds in the high atmosphere over Aden, is very variable, with a range of three weeks. Before the quantitative theory of the general circulation provided by mathematical physics is likely to help much in the problem of forecasting, it will surely need to incorporate in some way the monsoon changes. When we can understand and perhaps predict why one year differs so much from another, a great victory will have been gained.

Depressions and anticyclones

Weather maps usually show one or more regions of relatively low or relatively high pressure. Articles on the subject usually give the lion's share of attention to the depression, but the high pressure region is equally important and interesting, although as a region of subsided air that is relatively dry with little upper cloud or rainfall it is dynamically the simpler. It was recognised early that the depression was a region of rapidly changing winds bringing cool, dry air in its wake, but it was the Norwegians during World War I who codified the structure and brought forward in 1919 their famous cyclone model, since reproduced in every text-book. Briefly, their model was one of cold and warm air flowing side by side, the colder current naturally nearer the pole (polar air) and the warm current nearer the equator (tropical air), the two separated by a front. The cyclone development was correctly pictured as a large-scale eddy which swept up a portion of the warm air (warm sector) and replaced it by cold air, lifting the warm air from the surface in the process and so causing cloud and rain. On the whole, lifting means inflow or convergence to the centre which, due to the conservation of angular momentum, causes the air already possessing the spin of the earth to show greater spin as its area contracts. As a result, the air rotates relative to the earth in the same direction as the earth rotates round its axis, which defines cyclonic circulation. The model

permitted systematic weather analysis and was a great benefit in practical forecasting, but it was not a completely formulated dynamical model and described rather than explained the phenomena.

The success of the years since World War II in providing a truly dynamical cyclone model is therefore a very important step forward. It has contributed much to modern forecasting and has been built into methods of dynamical prediction that have been developed with electronic high-speed computers. The dynamical model differs from the earlier front and air-mass model in that the sharp division between cold and warm air is replaced by a broad zone of transition—a baroclinic zone. In this way, the dynamics of continuous fluids may be used instead of that of surfaces of discontinuity, giving results which are more general if in some respects less precise and providing an anti-cyclone model as the complement to the cyclone. During this same recent period, techniques of three-dimensional analysis have been evolved and fully agreed upon internationally so that every large synoptic centre now has, in addition to surface synoptic charts, charts for many pressure levels—700, 500, 300, 200, 100 mb, and sometimes others.

The dynamical model includes a wavelike distortion of the surface flow and pressure pattern associated with a similar wavelike distortion of the temperature field lagging nearly a half-wavelength behind (to the west). Since, by the hydrostatic equation, the temperature field represents the difference between the pressure fields at two levels and so also the wind shear, the phase difference between pressure and temperature waves allows upper divergence to coincide with lower convergence and the whole system is a self-developing mechanism providing all the most essential features of the depression. Elsewhere in the pattern, where the wave distortions place convergence above a region of lower divergence, the air subsides, becomes dry and warm, and provides an anticyclone model.

Although the simple dynamical models have greatly helped our understanding of what is happening and have permitted prediction by calculation, the fronts which they omit are, nevertheless, phenomena of nature. These fronts have been subjected to much observation and analysis, revealing many interesting features relating to the tropopause, stratosphere, and jet streams as well as to remarkable tongues of dry air whose existence was hitherto little suspected. The structure is indicated in Fig. 5: Fig. 5 (a) is based on the old idea of warm air sliding upwards over cold air, while Fig. 5 (b) is a schematic section based on recent observations showing the break in the tropopause, the jet-stream centre and a complicated dynamical overturning with subsiding dry air in advance of the rising cloudy air. To build the detailed dynamics of fronts into the broader dynamics of the baroclinic atmosphere is an outstanding problem.

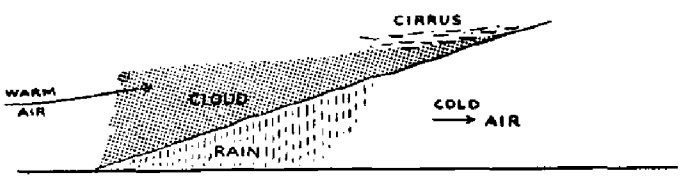


Fig. 5(*a*). Conventional drawing.

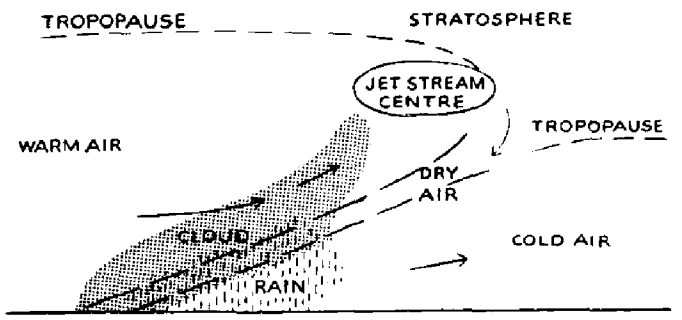


Fig. 5(*b*). Drawing based on recent observations.

Fig. 5. Section through a warm front.

Tropical revolving storms

Although they often bring rain where it is needed, these storms may be disastrous over a limited area. They have this in common with other depressions: a centre of low pressure and a wind circulation that is invariably in the same sense as the rotation of the earth (from west to east on the equatorial side); they are also associated with inflowing air near the surface, rising air above, and much cloud and rain. In many other respects, however, they are very different and have a different theoretical explanation.

Temperate-zone depressions are produced because cold and warm air flowing side by side have a transition region that is unstable and liable to curl up into a whirl; the large baroclinic whirl may go in either direction, giving either a depression or an anticyclone. The tropical revolving storm, by contrast, is caused by instability in the vertical and is driven by the latent heat liberated in rainfall; it has a warm core and apparently requires an exceptionally warm sea (with a temperature above 27°C or 81°F) to support it. These storms are scientifically remarkable; were the sea only a few degrees cooler, they might never occur at all, and if it were warmer they might, other things being equal, be much more frequent. In this respect, the atmosphere is delicately poised with potentialities for climatic change which have yet to be considered.

The effect of tropical revolving storms on the weather of other latitudes is not negligible, for the track of each storm is generally poleward near the continental coasts, bringing Japan and even Canada within their direct influence. Moreover, a number of temperate-zone depressions are triggered by tropical revolving storms arriving from the south; thus the centre of low pressure of a cyclone near Iceland may sometimes be traced back continuously to a hurricane in the tropics a week or more earlier. To the theoretician, the problem is challenging and has been partially solved, but the curious structure with spiralling arms and a warmer inner core of dry subsided air (the eye of the storm) has not yet been deduced by calculation. For the countries frequently subject to their damaging violence—especially, but not exclusively, China and Japan, India, and the United States—accurate prediction is worth a great deal of effort, which it certainly is receiving in America. Perhaps it is in this context that the investment in meteorological earth satellites will show its greatest dividend by providing photographs from space of all tropical cyclones as soon as they begin to take shape.

Showers and thunderstorms

While the tropical hurricane is a rare manifestation of vertical instability driven by the latent heat of condensation—so rare that the number present on Earth at one time is unlikely to reach ten and may fall to zero—the ordinary shower and its more intense variety, the thunderstorm, is common-place, occurring in thousands at all times and contributing a large fraction, indeed, the greater part, to the rainfall of the world. Basic theory on the nature of vertical instability in a moist atmosphere has advanced little beyond the elementary stage reached during the last century although the structure of thunderstorms has been intensively studied by aircraft, radar, and radiosonde, revealing features previously only conjectured—in particular, the amount of water in clouds and the nature of the intense downdraught which, brought down by rain and cooled by evaporation, produces intense squalls at ground-level. It used to be stated that a large variation of wind with height would distort and destroy any large convection system, but since storms often occur in frontal regions where there is a large wind shear with height, it has been recognised recently that a dynamical model for a persistent storm may demand a shear. The calculation of hail size, introducing the fall speed of the particles, as well as all the usual dynamical and thermodynamical factors, may be really formidable. Hail is traditionally the great destroyer in thunderstorms—far more important than the lightning except where forest fires are a hazard—but in recent years

danger to overhead power lines and radio interference have enhanced the importance of the electrical manifestation. By means of radio direction-finding, lightning counters, and perhaps by observations from earth satellites, it is possible, in principle, to monitor all the world's thunderstorms continuously and in time this may be found worth the cost.

The atmospheric heat engine

The dynamical systems which have been briefly described, from the general circulation itself down to small-scale showers, are, as it were, different units in the complicated inter-lock-up mechanism of the atmospheric heat engine.

In the process of degradation of energy from the input of short-wave solar radiation to the output of long-wave terrestrial heat to space, a small proportion is temporarily converted to the mechanical energy of the wind circulations which determine our weather and climate.

The mechanisms can be described with some certainty, and research must now complete the picture with satisfactory dynamical and, above all, thermodynamical theory. In the meantime, meteorology is pre-eminently a useful science which allows us to predict the weather within limits and even to dream of controlling it. Achievements and prospects in these practical pursuits will be described in the next number of *The Marine Observer*.

532.59:551.46.018

Wave Measurements made by the National Institute of Oceanography

By Mollie Darbyshire, B.Sc.

(National Institute of Oceanography)

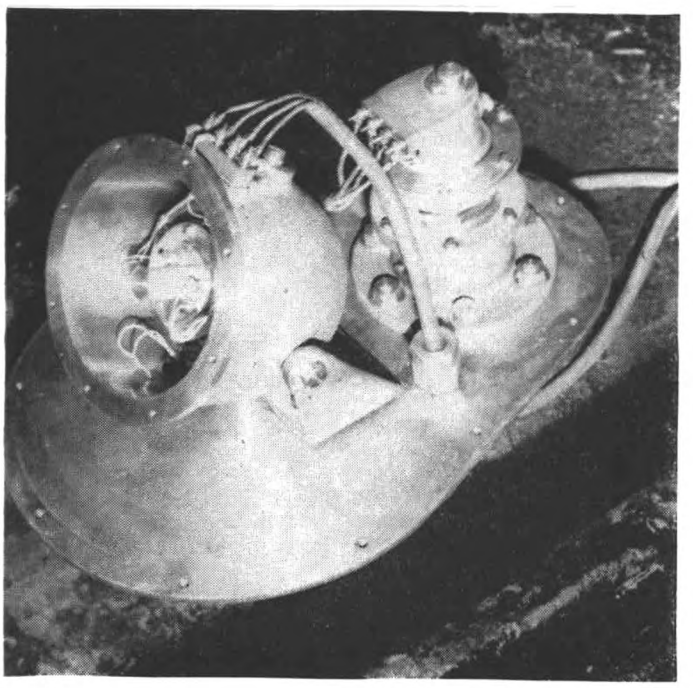
Introduction

The National Institute of Oceanography has been making instrumental measurements of sea waves since 1945. An account is given here of wave measurements made in the North Atlantic Ocean and around the coasts of Britain since that time, indicating what records are available and summarising the information which has been extracted from these records.

Methods of measuring waves

The first wave recordings were made with a pressure type recorder, placed on the sea bottom, which measured the difference in pressure as the wave crests and troughs passed over it. It could, of course, only be used near the coast as the wave height is attenuated with depth and it is only possible to measure the pressure differences at the bottom in fairly shallow water. Another limiting factor is the length of cable necessary to connect the instrument with the recording unit on shore. With the development of the ship-borne wave recorder, it became possible to measure waves in deep water (see photograph on opposite page). This instrument can measure waves from a ship which is itself moving under the action of the waves. Two identical units are mounted on the hull of the ship, one on each side, and the mean of their outputs is taken. Each unit consists of a pressure measuring head and an accelerometer. The pressure gives the height of the water surface above the recorder and the vertical component of the acceleration, integrated twice, allows for the fluctuation in the vertical displacement of the recorder due to the motion of the ship. The sum of these gives the variation in the height of the water surface independent of the position of the ship.

(*Opposite page 32*)



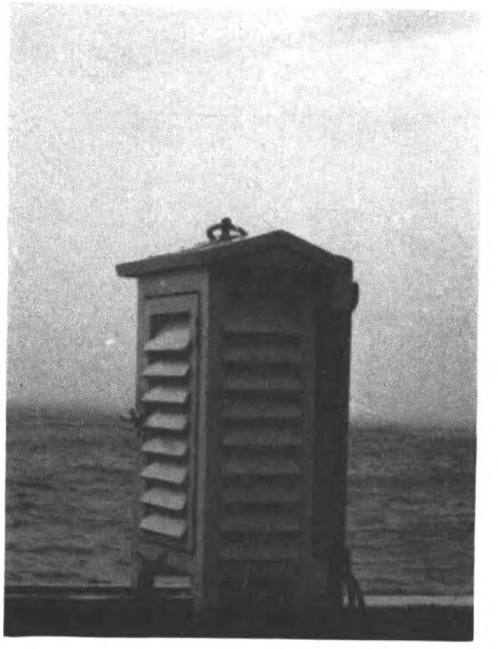


Photo by courtesy of R. Brass, Chief Radio Technician

Left-hand photo:

Ship-borne wave recorder in position fixed to the ship's hull with top cover plate removed to show inside.

Right-hand photo:

Exposure of screen on the port side of the bridge aboard a British weather ship; in addition to the conventional thermometers it has electrical resistance thermometers, connected to a recorder in the meteorological office, measuring wet and dry-bulb temperatures. A similar screen is mounted on the starboard side of the bridge.

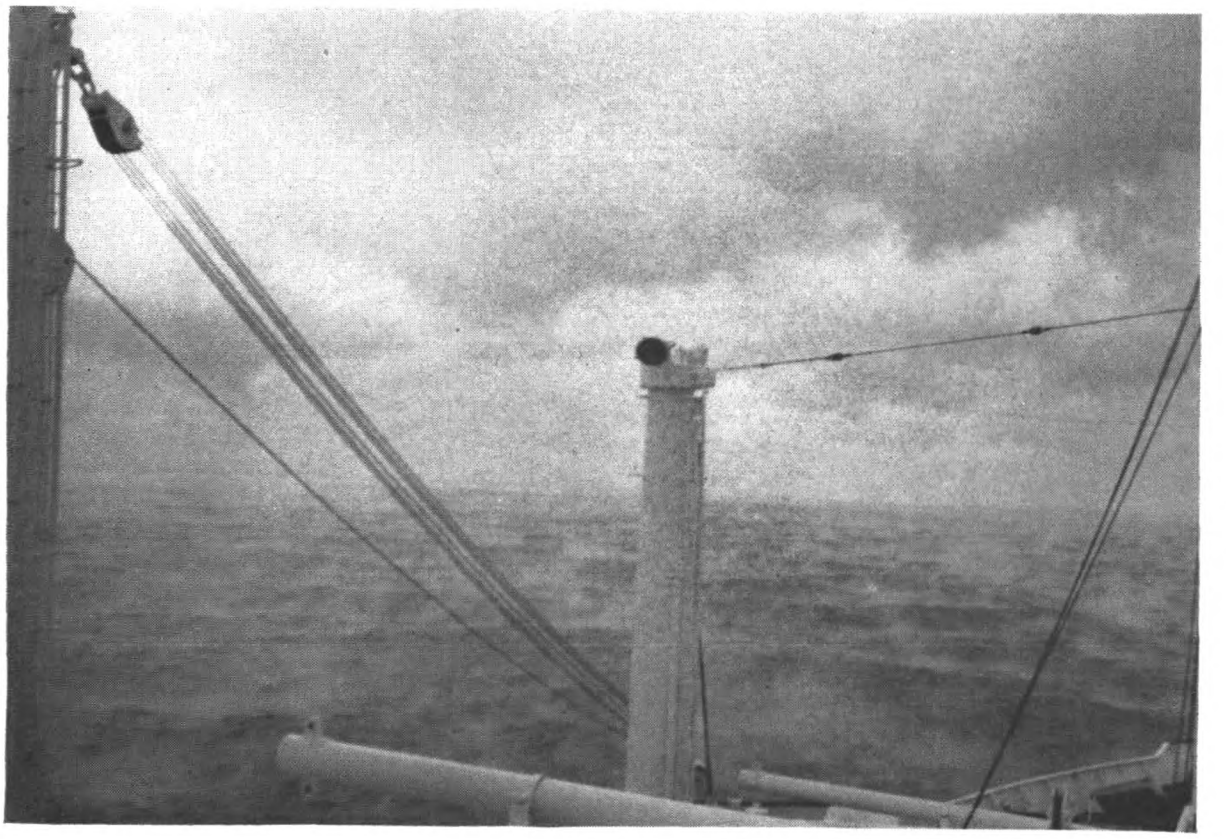


Photo by courtesy of J. B. Walker, Chief Officer

Sea smoke observed by s.s. *Empress of England* (see page 14).

(*Opposite page 33*)

Photo by courtesy of W. Ralston, Ltd., Glasgow

This photograph of O.W.S. *Weather Watcher* in dry dock illustrates rather aptly why the 'Flower' class corvettes proved such excellent sea-boats, not only during their strenuous escort duties in the war but throughout their service as weather ships in the Atlantic. The lovely lines, and deep immersion of propeller and rudder, stand out. With a length of 205 feet, they have a loaded draught of about 17 feet.

A description of various types of wave recorders and of the ship-born wave recorder has been given by Tucker.[1, 2]

Wave measuring in the ocean weather ships

Visual estimates of wave height, period and direction have been made in all the ocean weather ships and also in Selected Ships for many years. This information is transmitted to the forecasting section of the Meteorological Office by means of coded messages, and some of it appears in the published Daily Weather Reports. Although these estimates are extremely valuable, it is difficult to achieve a high degree of accuracy always, particularly in stormy weather conditions and in the presence of a sea and several sets of swell, forming what is known as a confused sea.

A ship-borne wave recorder has been in use in the *Weather Explorer*, and its successor the *Weather Reporter*, since February 1953, and a large collection of wave records has been built up. These ships have occupied various weather stations in the eastern North Atlantic, but for the majority of the time they have been on either station 'I' (59°N, 19°W) or 'J' (52½°N, 20°W). Records of about 15 minutes length are taken eight times a day while the ships are at sea.

These records give a measure of the wave height and the period but not the direction. The period can be measured directly from the chart but a correction must be applied to the height to allow for the falling off in the response of the instrument at high frequencies. This is given by the equation:

$$\text{True height/Recorded height} = 0{\cdot}83[1+(8{\cdot}8\times 2f)^{-2}]^{3/2} \exp 4\pi^2 f^2 kd/g$$

where the first part represents the electronic characteristics of the instrument and the exponential term represents the hydrodynamic effects; f is the wave frequency and d the depth of the instrument below the water-line. The values of d for the *Weather Explorer* and *Weather Reporter* are 11 feet and 7 feet. It has been found by experiment that the effective depth of the instrument is greater than the actual depth and it is necessary to multiply by a factor k which is about 2·5. The effective depth for the *Weather Reporter* was found[3] to be 17 feet and a similar ratio has been assumed for the *Weather Explorer*. A table of values can be drawn up and this correction easily applied. Values of wave height and period measured instrumentally give a useful check on the visual estimates and those taken by the other weather ships are found to be in reasonable agreement.

The ship-borne wave recorder can only be used effectively when the ship is stationary or moving at a speed of under 2 knots. At higher speeds, the periods become distorted according as the ship is moving into or with the waves. However, the values of height can still be made use of.

With a series of waves, the height of any wave is the vertical distance from the crest to the trough, whilst the wave period is the interval of time which elapses between the passage of two successive crests or troughs past a fixed point. Both with visual observations and with a wave record, it is possible to find the maximum wave height and the dominant and the mean period. Any wave record can, however, be resolved into a number of simple sine waves of different height and period. This can be done by harmonic analysis. A diagram of height plotted against period or frequency is known as a wave spectrum. Such a spectrum has been obtained from wave records taken in the *Weather Explorer*.[4]

When several series of waves which may have different directions are present in an area at the same time, they give rise to a very complicated pattern. Sea waves are those which are being generated by the local wind. Swell waves are either those which have been generated by a storm some distance away which have travelled to our area or those generated some time previously by a local wind which has now ceased to blow. Although there can be several series of swell present at any one time, there can only be one series of sea waves. Observers are asked to differentiate between sea and swell. This may be fairly easy to do in some circumstances but

where the directions of the wave series are similar, it is very difficult to detect even one swell, let alone more, in the presence of a locally generated sea. Under calm conditions, it is easy to determine the characteristics of any swell. The direction of the sea waves will be approximately the same as the wind but the swell may have any direction.

The wave height, period and spectrum can be predicted from the local wind for sea waves. Swell can be predicted by considering the wind over a wide area for a number of days. Waves of various period from the highest possible for the wind force acting down to very small ones are generated in the storm area. They travel at a velocity which is proportional to the wave period and so the higher period waves arrive first at the recording station. The summation of waves of different period appears as a series of groups of high waves separated by lower ones. Because half of the energy is left behind when the wave moves forward it is found that the wave groups move with a group velocity which is equal to half the wave velocity. From the wave spectrum at the generating area and using this group velocity, the movement of the swell can be predicted.

From these considerations, it can be seen that the wave recorder is an essential tool in the study of wave generation and in wave forecasting. It is now possible to forecast the height, period, and direction for the centre of each square of a grid covering the whole North Atlantic Ocean.[5] This is a first step to a system of wave forecasting whereby ships can be routed through the calmer areas, saving both time and fuel.

Wave recording has also been used in the study of ship motion. Extensive trials have been carried out in conjunction with the British Shipbuilding Research Association and the Ship Hydrodynamics Division of the National Physical Laboratory. Some of these were done in the *Weather Reporter* at station 'K'. Spectra of the various characteristics of ship motion such as pitch and roll were obtained and these were related to the wave spectrum.[6]

Coastal waves

A series of wave recordings was made near Perranporth on the north coast of Cornwall from August 1945 to January 1947. The recorder was a Cambridge pressure recorder placed on the sea bottom about a mile from the coast where the depth was 35 feet at low water springs. Recordings were made six times a day and the heights were corrected to allow for the attenuation with depth at the appropriate wave period.

Since November 1956 wave measurements have been made by a ship-borne wave recorder on board certain of the light-vessels near the British coast, with the co-operation of Trinity House. One ship-borne wave recorder has been in use throughout. From November 1956 to January 1959 it was installed in the *Morecambe Bay* light-vessel in the Irish Sea, 15 miles from the shore at a depth of 12 fathoms. Some very interesting results were obtained, for in a fairly small enclosed area of sea like this it is possible to study the effect of fetch, that is the distance over which the wind has been blowing. It was found that the values of height and period did not increase much more with fetch after 100 miles but for fetches of less than this the wave period and height decreased with decreasing fetch.[7, 8] In order to extend the work to longer fetches, the recorder was then moved to the *Smith's Knoll* light-vessel in the North Sea, 30 miles off the coast of East Anglia in 27 fathoms of water. Records from here are available from March 1959 to May 1960. The recorder was then moved again to the *Helwick* light-vessel in the Bristol Channel, south-west of the Gower Peninsula, and we have records from here from August 1960 to August 1961. This ship is in a more exposed position than the other two. It is in 22 fathoms of water near the Helwick Bank and quite a lot of swell from Atlantic storms reaches it. In this ship the recorder was fixed 4½ feet below the water-line and a comparison was made between these records and simultaneous ones taken with an accelerometer buoy.[9] The effective depth was found to be 10 feet, which

agrees well with the factor of 2·5 given previously. The depths of 6 feet and 5 feet for the *Morecambe Bay* and *Smith's Knoll* light-vessels were also multiplied by this factor.

The recorder is now being fitted in a still more exposed position in the *Seven Stones* light-vessel off the coast of Cornwall.

These records of waves in coastal waters have proved to be extremely useful as they have shown in what way the effect of short fetch and shallow water modifies the conditions found in the open ocean. This information is much sought after by the designers of breakwaters, harbours and other structures on the coast.

Explanation of tables

Some of the information derived from the records described is presented here in a series of tables. The maximum wave height and the mean wave period were found for each record and the distribution of these two variables with respect to each other is shown, expressed in parts per thousand. The wave heights are for classes at intervals of 2 feet, the figure given being the mid-point of the class, and the periods are for classes at intervals of 1 second. From these tables, it is possible to see immediately the highest and the most probable values of both height and period. The data have been divided into two groups to show the seasonal variation.

Table 1 includes data from all records taken by the weather ship during three of the years available, 1953, 1954, and 1959, when the ship was on station. This is for approximately half the days in the year. The column headed "ship moving" gives

Table 1(a)

Distribution in ‰ of maximum wave heights, and periods, measured by O.W.S. "Weather Explorer" during the months March–August for the years 1953, 1954 and 1959

(Number of observations = 1976)

Maximum wave height (feet) \ Wave period (seconds)	5	6	7	8	9	10	11	12	13	Ship moving	Total
3		1		1							2
5		3	4	4	2	1				2	16
7	1	9	24	10	5	1				8	58
9	1	16	28	19	7	2	1			10	84
11	1	12	36	20	8	1	1			17	96
13	2	15	41	39	12	3	1			14	127
15	2	19	41	19	10	3	1			12	107
17		10	35	38	21	5	2	1		15	127
19		8	26	21	18	6	2		1	10	92
21		3	20	16	17	5	2			13	76
23		4	20	20	10	5	2	1		6	68
25		1	10	7	5	3	1	1		8	36
27		1	9	14	7	1	1	1		6	40
29			2	5	6	1	1			5	20
31		1	4	5	4	2	1			2	19
33			1	2	1	1				1	6
35			1	1	2	1				1	6
37				1	1	1				1	4
39			1	1	2		1				5
41			1	2	1						4
43				1	1						2
45							1				1
47						1	1				2
49								1			1
51											
53											
55											
57											
59								1			1
Total	7	103	304	246	140	43	19	6	1	131	1000

Table 1 (b)

Distribution in ‰ of maximum wave heights, and periods, measured by O.W.S. "Weather Explorer" during the months September–February for the years 1953, 1954 and 1959

(Number of observations = 1642)

Maximum wave height (feet) \ Wave period (seconds)	5	6	7	8	9	10	11	12	13	14	15	Ship moving	Total
5			1	1									2
7		1	6	3	3	2						1	16
9		2	5	5	2	1	1					2	18
11		2	9	6	9	4	3	1				7	41
13	1	1	14	17	12	5	1					9	60
15		1	16	17	10	4	1					8	57
17		2	16	30	18	8	2	2				10	88
19		1	8	24	18	4	4	1				10	69
21			9	16	24	10	4	1				7	71
23		1	10	30	27	6	4					12	90
25		1	9	11	18	7	7	1	1			7	62
27			7	25	21	7	1	1				10	72
29			5	11	20	12	2	1	1			9	61
31		1	1	14	27	4	3	1				9	60
33			2	11	15	7	3	2	1			3	44
35			2	6	11	12	3					7	41
37			1	1	9	4	3					4	22
39			1	4	9	7	2	1				5	29
41				3	8	2	4	1	1			7	26
43				1	5	3	1				1	1	12
45				1	3	5	2	1				1	13
47				1	2	4	1	1				2	10
49				1	2	2	1		1	1		4	12
51				1	1	1	2	1			1	2	9
53					1				1				2
55					1		2		1			2	6
57				1	1		1						3
59					1	1							2
61							1						1
63								1					1
Total	1	13	122	241	278	122	59	17	7	1	2	139	1000

Table 2(a)

Distribution in ‰ of maximum wave heights, and periods, at Perranporth for the months April–September

(Number of observations = 970)

Maximum wave height (feet) \ Wave period (seconds)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1			1	3	15	12	4	3	3	3					44
3	1	17	36	53	35	37	16	8	6	6	1			2	218
5	3	24	51	72	56	52	33	14			1	1			307
7	3	12	27	30	43	36	13	9	1	3	2				179
9	1	3	14	19	25	24	12	7	1	4		1			111
11	3	2	11	15	9	12	8	7	2	4					73
13	1	3	1	4	7	16	2	2	1						37
15			2	6	1	3	1	2		1					16
17				1		3	1								5
19			1				2	1							4
21			1		1										2
23						2	1								3
25															
27							1								1
Total	12	61	145	203	192	197	94	53	14	21	4	2		2	1000

Table 2(b)

Distribution in ‰ of maximum wave heights, and periods, at Perranporth for the months October–March

(Number of observations = 1015)

Maximum wave height (feet) \ Wave period (seconds)	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1		2	5	18	8	17	5	2		1					58
3	1	7	11	30	54	52	24	16	11	5	2		2		215
5	6	8	17	28	49	52	34	18	9	7	4				232
7	5	10		7	14	34	24	15	7	8	6		1	1	132
9	2	1	2	3	12	10	21	7	14	5	4	4			85
11	1	1	2	8	4	19	16	17	12	10	3	3		1	97
13		3	3	3	7	8	6	4	8	8	3	3			56
15		1	1		4	14	7	3	7	3	4		1		45
17			2	2	2	14	11	5	4	3	4	1			48
19				2	1	4	1		2	1	1	2			14
21				1	1	2		1	1		3	1			10
23									1	1	2				4
25												1			1
27										1					1
29															
31													1		1
33						1									1
Total	15	33	43	102	156	227	149	88	76	53	36	15	5	2	1000

Table 3(a)

Distribution in ‰ of maximum wave heights, and periods, at "Morecambe Bay" light-vessel for the months March–August

(Number of observations = 1523)

Maximum wave height (feet) \ Wave period (seconds)	2	3	4	5	6	7	8	Not measurable	Total
1		60	30	19	21	10	1	348	489
3	27	77	63	79	27	4	2		279
5	3	11	18	39	30	2			103
7			1	36	33				70
9				11	22				33
11				3	2	1			6
13						5	1		6
15					2	2	1		5
17					1	2	1		4
19					1	1	1		3
21						1	1		2
Total	30	148	112	187	139	28	8	348	1000

the wave height but not the period, as the ship was moving at more than 2 knots in heavy seas in order to keep on station.

Table 2 gives data for Perranporth for the complete year of 1946. Table 3 gives data from *Morecambe Bay* for December 1956 to November 1957. A large number of these records were almost flat and it was not possible to measure the wave period. These have been included in the 1-foot class. Table 4 gives data from *Smith's Knoll* for April 1959 to March 1960. Table 5(b) gives the data for *Helwick* for September 1960 to February 1961 and Table 5(a) for March, April, and May, 1961.

Table 3(b)

Distribution in ‰ of maximum wave heights, and periods, at "Morecambe Bay" light-vessel for the months September–February

Wave period (seconds) (Number of observations = 1795)

Maximum wave height (feet)	2	3	4	5	6	7	8	9	10	Not measurable	Total
1		49	32	38	21	5	2			96	243
3	29	57	49	63	59	13	2				272
5	2	22	28	54	62	15	3	1			187
7		2	11	33	51	22	4				123
9	1	2	4	12	26	19	8				72
11				4	17	12	8	2			43
13					7	8	7	4	1		27
15				1	6	3	2	2	1		15
17					4	2	3	1	1		11
19						1	1	1	1		4
21							1				1
23								1			1
25											
27											
29						1					1
Total	32	132	124	205	253	101	41	12	4	96	1000

Table 4(a)

Distribution in ‰ of maximum wave heights, and periods, at "Smith's Knoll" light-vessel for the months March-August

Wave period (seconds) (Number of observations = 2095)

Maximum wave height (feet)	3	4	5	6	7	8	Total
1	47	85	65	35	9	3	244
3	23	73	144	72	18	3	333
5	2	18	89	78	16	1	204
7		2	49	48	10	2	111
9		1	20	31	5	1	58
11			10	11	5	1	27
13			1	7	4		12
15			1	4	2	1	8
17				2	1		3
Total	72	179	379	288	70	12	1000

Table 4(b)

Distribution in ‰ of maximum wave heights, and periods, at "Smith's Knoll" light-vessel for the months September–February

Wave period (seconds) (Number of observations = 2001)

Maximum wave height (feet)	3	4	5	6	7	8	9	Total
1	46	52	12	4	1			115
3	17	86	84	27	3			217
5	9	57	113	46	6	1	1	233
7	1	32	63	59	10			165
9		1	38	52	20			111
11		1	18	35	13			67
13			8	18	12	6		44
15			2	10	9	2		23
17			1	6	3	1		11
19			1	2	1	1		5
21				1	2	2		5
23				1	1	1		3
25						1		1
Total	73	229	340	261	81	15	1	1000

Table 5(a)

Distribution in ‰ of maximum wave heights, and periods, at "Helwick" light-vessel for the months March April and May

Wave period (seconds) (Number of observations = 639)

Maximum wave height (feet)	3	4	5	6	7	8	9	10	11	Total
1	25	23	28	9	9	9	13	2	3	121
3	20	32	27	13	14	9	17	5	2	139
5	13	25	37	33	28	14	6			156
7	2	38	38	42	22	17	5			164
9	2	22	56	49	25	8				162
11		11	30	30	24	2	3	2		102
13			19	39	17	2	2			79
15		2	6	19	11					38
17			8	12	5					25
19				3	3					6
21				5						5
23				3						3
Total	62	153	249	257	158	61	46	9	5	1000

Table 5(b)

Distribution in ‰ of maximum wave heights, and periods, at "Helwick" light-vessel for the months September–February

Wave period (seconds) (Number of observations = 1443)

Maximum wave height (feet)	3	4	5	6	7	8	9	10	11	Total
1				1	1					2
3	6	10	20	22	11	3	1	1		74
5	13	37	47	16	17	7	1	4		142
7	5	33	69	30	17	17	3	3	1	178
9	1	19	52	37	13	13	1	1	1	138
11	1	7	40	39	21	9	3	3	1	124
13		1	25	36	22	7	2	1		94
15		1	21	33	19	10	3	1	1	89
17			6	23	15	6	1	1		52
19			4	10	14	8	1			37
21			2	10	9	5	1	1		28
23			1	5	5	3	1			15
25			2	4	5	3	1			15
27				1	2	2				5
29					1	1				2
31				1	2	1				4
33						1				1
Total	26	108	289	268	174	96	19	16	4	1000

Discussion of results

In the North Atlantic Ocean, the wave heights and periods recorded cover a wide range of values. Waves of 60 feet and over can be expected several times a year. Periods range from 5 to 15 seconds, the most common in winter being 9 seconds, and in summer 7 seconds. In coastal waters the values are much less, as would be expected. At the three light-vessels, the period most frequently recorded is 5 to 6 seconds and the range is from about 2 to 10 seconds. At Perranporth the values are considerably higher, probably due to the high incidence of swell from the Atlantic. The maximum heights recorded vary from place to place—33 feet at Perranporth and *Helwick* light-vessel, 29 feet at *Morecambe Bay* light-vessel, and 25 feet at *Smith's Knoll* light-vessel. The most common value of height at *Helwick* light-vessel and Perranporth is about 6 feet, at *Smith's Knoll* light-vessel about

4 feet, and at *Morecambe Bay* light-vessel it is very low, being only about 1 foot. This last is due to the very small fetch in the easterly direction.

A study of these tables gives some indication of the most likely and worst possible conditions to be encountered in the North Atlantic and in British coastal waters and also shows the differences between the winter and summer months.

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NOTES ON ICE CONDITIONS IN AREAS ADJACENT TO THE NORTH ATLANTIC OCEAN FROM JULY TO SEPTEMBER 1961

At end of July 1961

RELEVANT WEATHER FACTORS

Early in July pressure was high over the Arctic on the Atlantic side and towards the Russian seaboard, but below normal north of the Bering Strait. In the latter half of the month cyclonic activity developed from the Davis Strait, over southern Greenland and across the Atlantic to north-west Europe and the Barents Sea.

Pressure in the Azores high was above normal throughout the month and it extended towards western Europe. In July surface air masses were on average warmer than normal over north-east Canada, northern Greenland, and the Barents Sea. Air masses over the North Atlantic from Newfoundland and Labrador to the British Isles and Scandinavia were colder than normal. Sea temperatures were below normal over most of the North Atlantic, but above normal at the southern end, and probably over most, of the Denmark Strait.

CANADIAN ARCTIC ARCHIPELAGO

Since the end of June there was a considerable increase in the open water throughout this area. The area of almost permanent fast-ice adjacent to the Arctic Basin appeared to be much less than normal. Variable extensive pack-ice remained in Foxe Basin. Off the south-western shores of Hudson Bay considerable areas of close pack-ice remained but most of the Bay was covered by open water. There was also much open water in Hudson Strait with, apparently, small numbers of icebergs.

BAFFIN BAY

The amount of open water had increased rapidly and by the end of July it was well above normal. The Greenland coast was almost free of pack-ice though many ice-floes of all sizes, concentrations and thicknesses remained in Smith Sound, Kane Basin and Robeson Channel: i.e. this entry into the Bay probably remained blocked. Large numbers of icebergs were reported off the Greenland coast. Most land stations reported more than 50, probably as a result of high temperatures and favourable easterly winds over northern Greenland. Variable numbers of icebergs were reported off the Canadian coast with large concentrations locally (i.e. more than 20 at a single sighting).

DAVIS STRAIT

Davis Strait was mainly free of pack-ice apart from a considerable area of close pack-ice containing icebergs off Baffin Island. Inlets and bays of Baffin Island had fast-ice locally but most fast-ice had become free and was moving. Icebergs were moving southwards in

decreasing numbers along the Labrador coast. The Greenland coast was free of pack-ice with most land stations observing 5 or less icebergs.

BELLE ISLE STRAIT

The Strait was free of pack-ice but icebergs continued to be reported at the entrance.

GREAT BANK

There was no pack-ice over the Great Bank but icebergs continued to move southwards on to the northern edge. None was reported either south of 48°N or east of 46°W. The southward drift of icebergs was decreasing in number and extent; both were well below normal. The table on page 44 gives the number of icebergs observed over the Great Bank during July, August and September.

GULF OF ST. LAWRENCE AND ST. LAWRENCE RIVER

These were free of ice throughout the period July to September.

GREENLAND SEA

North of 75°N, pack-ice extended out from the east coast of Greenland to the Greenwich Meridian but had retreated westward from Jan Mayen. Land stations reported 16 to 50 icebergs within the pack-ice. Polar ice moved westwards round the south of Spitzbergen and polar floes were observed 20 to 40 miles from the coast.

DENMARK STRAIT AND ICELANDIC WATERS

Ice in the Denmark Strait was well below normal in area. Close pack-ice with open water near the coast extended southwards from Scoresby Sound along the coast and to halfway across the Strait towards Iceland, but south of the Arctic Circle there was little or no pack-ice. Land stations each reported more than 100 icebergs within the pack-ice but less than 50 moving south in the open water south of the Arctic Circle. Off Cape Farewell no pack-ice was reported and most land stations observed less than 15 icebergs.

BARENTS SEA

The flow of polar ice round Spitzbergen suggests that polar pack was moving southwards east of Spitzbergen. Elsewhere in this area climatic conditions suggest that the area of ice was less than normal at all times with Scandinavian and Russian coastal areas ice-free.

BALTIC SEA

From July to September no ice was reported in the Baltic Sea.

End of August 1961

RELEVANT WEATHER FACTORS

During August pressure was high and above normal over the Arctic Basin with cyclonic activity above normal over northern Canada, southern Greenland, the Atlantic north of 50°N and north-west Europe. Winds from the east were unusually frequent and strong over northern Greenland.

Air masses over the Arctic and sea areas between Greenland and Europe (including the Barents Sea) were warmer than normal; those over north-east Canada, and over the Bering Strait and adjacent Arctic, were colder than normal.

In the north-west part of the North Atlantic sea temperatures were below normal but in the north-east part they were normal or above normal.

CANADIAN ARCTIC ARCHIPELAGO

The amount of open water continued to increase rapidly in August and the amount of fast-ice in the extreme north decreased accordingly. Hudson Bay, Hudson Strait and most of Foxe Basin were free of pack-ice apart from isolated areas. Increasing numbers of icebergs were observed at the eastern end of the Hudson Strait.

BAFFIN BAY

Most of this area was free of ice. Ice floes in Smith Sound and Kane Basin appeared to have been breaking up and pack-ice off North Baffin Island had almost dispersed but icebergs remained. Most of the Greenland coast was free of pack-ice. Land stations towards 70°N mostly observed more than 200 icebergs. Although the number of icebergs reported off western Greenland varied, it appears possible from the large numbers reported locally that, in August and July, large numbers were leaving the glaciers. They were probably associated with the high temperatures of July and the persistent easterly wind anomaly over northern Greenland.

DAVIS STRAIT

There were few changes in the ice of this area from that observed at the end of July. Land stations of south-western Greenland continued to report less than 15 icebergs. Pack-ice was rapidly dispersing off Baffin Island. Large numbers of icebergs (i.e. more than 20 at a single sighting) were observed at the entrance to Hudson Strait but there were probably less than normal.

Belle Isle Strait and Great Bank

Icebergs were reported at the entrance of the Strait and along the eastern half. (See table on page 44.) Isolated bergs moved southward towards the northern edge of the Great Bank.

Greenland Sea

The area of pack-ice off eastern Greenland was decreasing but it remained slightly above normal. Land stations mostly reported between 16 and 50 icebergs moving southwards within the pack-ice. There was no pack-ice reported off western Spitzbergen or around Bear Island.

Denmark Strait and Icelandic Waters

During August extensive close pack-ice adjacent to Scoresby Sound moved southwards and extended along the Greenland coast in a narrow belt to south of the Arctic Circle. At the end of the month some land stations reported more than 100 icebergs within this pack-ice. Along the Greenland coast south of the belt of pack-ice, between 16 and 50 icebergs were reported moving southwards towards Cape Farewell where there was no pack-ice and no land station observed more than 5 icebergs.

Barents Sea

The area of pack-ice in the Barents Sea was probably less than normal, and Scandinavian and Russian coastal areas were ice-free. Amounts of polar pack-ice east of Spitzbergen were probably less than normal.

At end of September 1961

Relevant Weather Factors

During September, depression activity was greater than normal from Hudson Bay across Greenland to the Barents Sea. Pressure was generally high over the Arctic Basin with a large anticyclone over Europe. Cold air masses were advected southwards over northern Canada and northern Greenland and then further south into the north-west North Atlantic. Warmer air than normal covered western Europe and the Barents Sea. Winds over northern Greenland continued to be more easterly than normal and probably caused an increase in the transport of icebergs southwards in Baffin Bay. Sea temperatures remained below normal in the north-west North Atlantic and above normal off south-west Europe, but were normal in Denmark Strait and between Iceland and north-west Europe.

Canadian Arctic Archipelago

Much open water remained over the whole of the area, including Hudson Bay. Further reports in early October suggest that the cold air over northern Canada was producing large areas of young ice and some fast-ice in Hudson Bay. Many icebergs (more than 20 at a sighting) were reported in the eastern half of Hudson Strait.

Baffin Bay

Baffin Bay continued to be covered mainly by open water. Pack-ice appeared to be moving into the north of the Bay from Smith Sound. Some land stations of western Greenland towards 70°N continued to report more than 200 icebergs. There were local reports of very large numbers of icebergs (more than 100 at a sighting) along the Canadian side of the Bay. Again, more recent reports have indicated that young ice was forming in the north-west of Baffin Bay.

Davis Strait

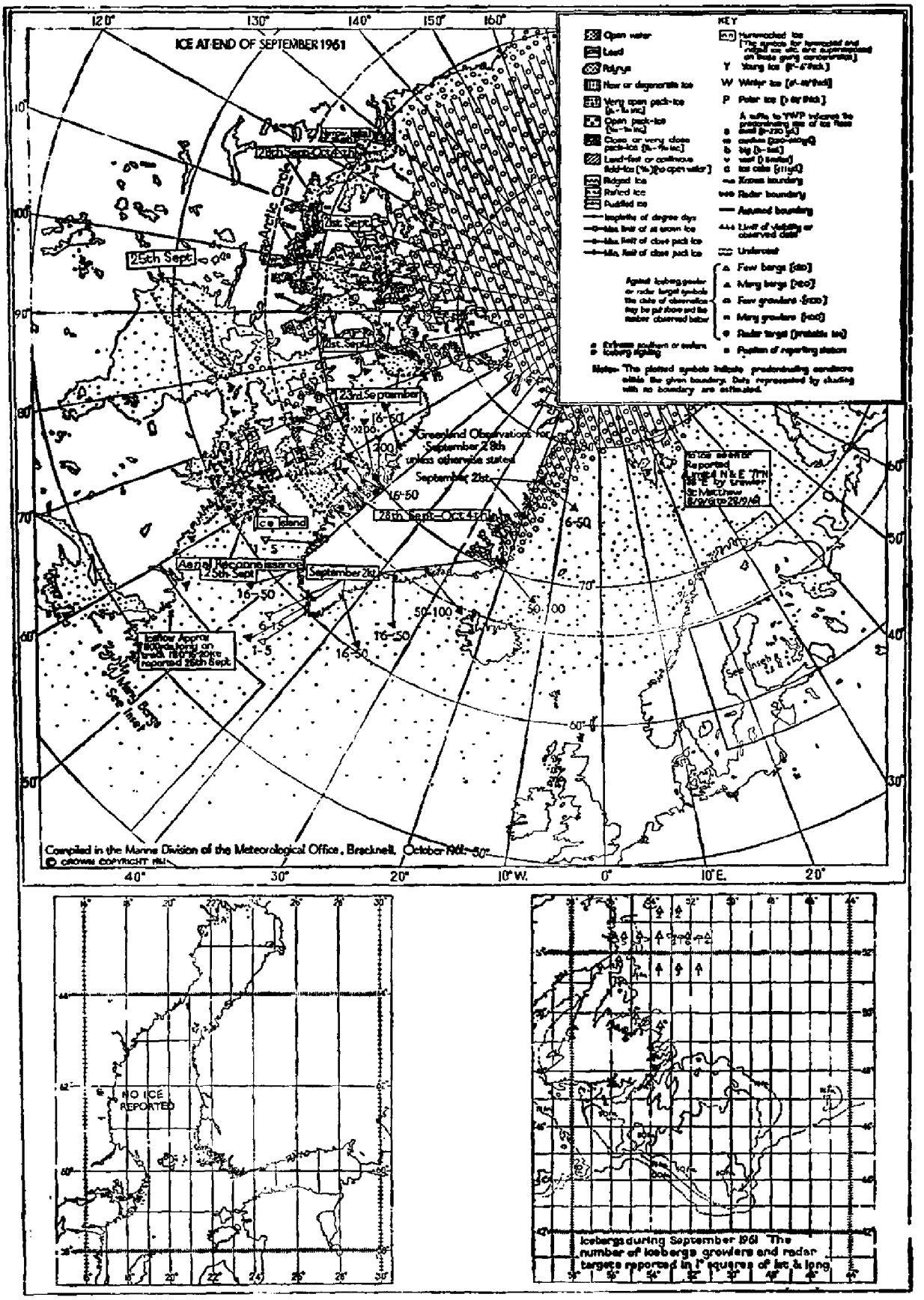
Of special interest is a large area between 60°W and the entrance to Hudson Strait over which many icebergs were distributed; it seems likely that these icebergs were released from northern Greenland in previous months. There was no corresponding increase in the number of icebergs arriving further south off Labrador. Most land stations of south-west Greenland reported observing less than 5 icebergs while the number of icebergs moving south along the Labrador coast continued to decrease. The whole of Davis Strait was apparently free of pack-ice.

Belle Isle Strait and Great Bank

Icebergs continued to be reported at the entrance and halfway along the Strait. Off Newfoundland icebergs were still moving south in decreasing numbers but the Great Bank was apparently clear of ice.

Greenland Sea

Climatic conditions suggest that during September it is likely that in the extreme north the pack-ice consolidated; further south a general retreat to the west and north of the ice-edge probably occurred. At the end of the month land stations mostly reported 16–50 icebergs within the pack-ice. No ice was reported off western Spitzbergen or Bear Island.



Denmark Strait and Icelandic Waters

No ice was reported in this area but moderate or large numbers of icebergs were moving southward along the Greenland coast in the open water. Land stations reported between 16 and 100 icebergs.

BARENTS SEA

Climatic conditions suggest that the mass of all types of ice was probably less than normal in this area. It is likely that most of the Barents Sea south of 80°N was free of ice.

Icebergs Sighted by Merchant Ships in the North Atlantic

(This does not include growlers or radar targets)

LIMITS OF LATITUDE AND LONGITUDE		DEGREES NORTH AND WEST								
		56	54	52	50	48	46	44	42	40
Number of bergs reported south of limit	JULY	*	> 146	> 82	> 43	0	0	0	0	0
	AUGUST	> 71	> 66	> 40	> 20	4	3	3	1	0
	SEPTEMBER	*	43	20	3	0	0	0	0	0
	Total		> 255	> 142	> 66	4	3	3	1	0
Number of bergs reported east of limit	JULY	> 145	> 115	> 53	> 17	1	0	0	0	0
	AUGUST	> 68	> 41	> 24	> 13	2	0	0	0	0
	SEPTEMBER	41	22	5	0	0	0	0	0	0
	Total	> 254	> 178	> 82	> 30	3	0	0	0	0
Extreme southern limit	JULY	48° 00'N 46° 55'W on 2.7.61								
	AUGUST	40° 51'N 49° 42'W on 11.8.61								
	SEPTEMBER	49° 46'N 53° 15'W on 14.9.61								
Extreme eastern limit	JULY	48° 00'N 46° 55'W on 2.7.61								
	AUGUST	49° 30'N 47° 25'W on 15.8.61								
	SEPTEMBER	52° 27'N 51° 46'W on 1.9.61 52° 01'N 51° 46'W on 4.9.61								

* No observations between 54° and 56°N, but large numbers of icebergs probably present in addition to those further south.

> ("greater than") has been inserted where there is some doubt as to the actual number of icebergs at some of the sightings, but the true value is probably more than the value given.

Sources of data

The information contained in these notes is compiled from maps and broadcasts kindly provided by the Canadian Meteorological Service, the United States Hydrographic Office and Coast Guard, and the ice-reporting services of the countries of the Baltic sea. Reports from Greenland stations and special ice reconnaissances are obtained from Angmagssalik Radio. The Norwegian Meteorological Service and Fisheries Research Institute provide special reports from Spitzbergen, Bear Island and the ice limit north of Iceland. We receive reports from a world-wide distribution of ports via the Special Circular of the Baltic and International Maritime Conference.

G. A. T.

Note.—These notes are based on information plotted on ice charts each month, similar to the map for September on page 43, but on a much larger scale (39 in. × 27 in.). They are available at the price of reproduction on application to the Director General, Meteorological Office (M.O.1), London Road, Bracknell, Berks. Alternatively, they may be seen at any Port Meteorological Office or Merchant Navy Agency.

RADIO FACSIMILE BROADCASTS IN AUSTRALIA

Radio facsimile broadcasts were commenced from Canberra (AXM) on 11th August 1961. Although not primarily intended for shipping, the transmissions include surface analyses for the surrounding oceans which will doubtless be of interest to any ships in those waters which are equipped with suitable facsimile recorders. It is believed that Australia is the first country in the southern hemisphere to introduce facsimile for meteorological purposes.

Surface analyses for the area 5°S–50°S, 90°E–180°E for 2300, 0500, 1100 and 1700 are transmitted at 0118, 0718, 1318 and 1918 respectively. A surface analysis for the Southern Ocean (south of 30°S, 40°E–180°E) for 0600 is transmitted at 1118.

CALL SIGN	FREQUENCY (kc/s)	TIMES OF USE (GMT)	POWER OF STATION
AXM 31	2628	1000–2200	500 W
AXM 32	5100	Throughout	5 KW
AXM 34	11030	Throughout	10 KW
AXM 35	13920	Throughout	20 KW
AXM 37	19690	2200–1000	20 KW

Details of transmissions from Canberra are as above. The index of co-operation is 576, the type of modulation is F_4, and the frequency shift is given as White + 400 C/s, Black − 400 C/s.

LOCUST REPORTS FROM SHIPS

In last July's issue of *The Marine Observer*, we printed details of the information to be sent by radio whenever locusts are sighted at sea by voluntary observing ships, in accordance with the scheme organised by the World Meteorological Organisation on behalf of the Anti-Locust Research Centre in London.

We are glad to inform voluntary observers that the Centre was able to report by mid-August that, as a result of this international scheme, they had already received reports of Desert Locusts seen over the Red Sea, Persian Gulf, Arabian Sea and Gulf of Aden, from American, British, Dutch, Egyptian and French ships, and that in several cases these reports had helped them to give warning of changes in the locust situation to countries concerned.

Book Reviews

Maritime Meteorology, by G. E. Earl and N. Peter. 8½ in. × 5½ in. pp. 122. *Illus.* The Maritime Press, Ltd., London, 1961. 10*s.* 6*d.*

This book provides an elementary approach to the syllabus of the Ministry of Transport examinations and its contents are designed in particular to assist candidates. It is not to be expected that a volume of such limited size could cover such a large field in any great detail and the reviewer is glad to note that the authors claim no more for it than that it is "a basic text intended as a short but comprehensive introduction to the subject which will, it is hoped, encourage readers to widen their knowledge further by passing on to the more detailed manuals already available".

The book is divided into fourteen chapters, six purely meteorological and one each on optical phenomena, ocean currents, waves, ice, weather forecasts and bulletins, the weather map, ocean passages and meteorological instruments. The syllabus for Skipper, Master (home-trade), First Mate and Master are given, but that for Extra-Master is omitted. This is perhaps wise, for although candidates for the other grades would possibly find here all they need to get them through their examinations, those for Extra-Master would do well to go to one of "the more detailed manuals already available" before they venture into the examination room.

Though in the main accurate, the information, condensed as it is bound to be, is sometimes over-simplified. For instance the chapter on optical phenomena gives only mirages, haloes, coronae and rainbows, whereas iridescent clouds, crepuscular rays and twilight colouration and many other phenomena each with a meteorological implication surely deserve at least a mention. The habits of tropical revolving storms are made to appear much too definite; they are said to recurve in latitude 25°, a position which has in recent years proved to be very rough; those of the North Atlantic are said to be active from June to October (perhaps a survival from the "June, too soon, October, all over" days). It would have been better to have given this information in tabular form, for recent advances in the technique of storm detection have shown that the seasons are considerably longer than thought a few years ago, and that out-of-season storms are by no means uncommon. Towards the end of the chapter, however, the authors wisely state that "the wretched things are a law unto themselves". Again, we read that "Radar reports of icebergs in the northern hemisphere have not been entirely satisfactory" whilst "Radar reports of icebergs in the southern hemisphere have been satisfactory". The reader may well be puzzled as to why this is so, because it is not mentioned that the comparatively small northern iceberg with its many sloping sides may give a poorer radar response than its massive steep-to opposite number down south. In another place it is stated

that "All trans-Atlantic steamships are required to keep to certain tracks". This is not so for, though the North Atlantic Track Agreement has been in existence for many years, its provisions are still only a recommendation, albeit a strong one.

Some comment on the incomplete guidance to further information must also be made. For instance *M.O.*509, *Decode for Use of Shipping* and *The Marine Observer's Handbook* are mentioned, but we are not told what these publications are, nor yet where to get them. They are, of course, both very well known to the voluntary marine observer but to some Merchant Navy officers they may be unknown, even by name.

Indeed, since the authors have, in their preface, expressed the hope that their book will encourage readers to widen their knowledge, the omission of a bibliography or at least, of a few titles of works recommended for further study, is unfortunate.

The book, however, does what its authors claim for it and a study of its contents would be an admirable way of brushing up one's meteorology before facing the examiners. Its many diagrams are clear, comprehensive and easily retained in the memory, a great asset at such times. But there is more in maritime meteorology than the mere passing of examinations, and it is to be hoped that no officer will consider its purchase as the end of the road.

L. B. P.

The Principles and Practice of Radio Direction Finding, by Charles H. Cotter, B.SC. $8\frac{3}{4}$ in. × $5\frac{1}{2}$ in. pp. 117. *Illus.* Sir Isaac Pitman & Sons, Ltd., London, 1961. 21*s.*

As stated by the author in the preface, this book is intended primarily for the use of navigating officers and in particular for those students of navigation who are preparing for either the First Mate's or Master's examinations set by the Ministry of Transport.

It is divided into four parts; the first, under the heading of General Electricity, Electronics and Radio, gives sufficient detail for the student to understand some of the fundamental principles of electricity and magnetism. Electrical potential, electromagnetic and electrostatic fields, resistance, inductance, capacity, the oscillatory circuit and the propagation of radio waves are adequately covered.

The second part deals with the principles of radio direction finding. The rotating loop is dealt with in detail and the differences between it and the Bellini-Tosi fixed loop are explained. The determination of 'sense' is clearly explained, while a fairly large section is devoted to the various errors which are likely to be experienced in radio direction finders and to the means of their elimination where this is possible.

The third part, which is headed the Practice of Radio Direction Finding, explains the precautions to be observed when siting loops on board ship and the value of a good initial calibration of the instrument. Details are given of the methods by which calibration can be carried out. There is a section devoted to radio direction finding shore stations and how these are used to obtain a position line or fix. The use of the half-convergency correction is explained and the method by which it is applied.

The radio beacon system used in north-west Europe and those used in other areas are described, and attention is drawn to the special calibration services available. The part played by the ocean weather ships in the radio beacon system is mentioned. The remainder of the chapter is devoted to the adjustment and manipulation of four commercial types of direction finder in use today, including a visual presentation type which gives the bearing indication on a cathode ray tube.

Part four explains the basic principles and practical use of Consol, which the author points out is mainly an aid to air navigation but may be of value to mariners. The reason for including this system in a book which is essentially about direction finding is evidently that the direction finder is a good receiver to use for obtaining a Consol position line. The book concludes with a copy of the Ministry of Trans-

port Notice M.402 which sets out in detail the recommendations for the installation, calibration, and maintenance of direction finders on board ship. Much of the substance of this notice has been incorporated in the operational section.

Included also is a simple account of the part played in radio communication by ionised layers high in the atmosphere. The effect of the sun and cosmic radiation, and the Kennelly—Heaviside and Appleton layers, are all briefly mentioned. No mention is made, however, of the effect of the atmosphere at lower levels, e.g. of temperature inversions, ducting, etc., on propagation.

Undoubtedly this is a useful little book fulfilling the author's objective. It is well supplied with diagrams. There are, however, a few technical errors in the sections covering the theory and operational use; also, events have rather overtaken the author between preparation and publication, making the book not quite so up-to-date as it might be.

F. J. WYLIE

Personalities

RETIREMENT.—CAPTAIN W. T. BANKS recently completed his last voyage at sea in command of the *Strathnaver*.

William Thomas Banks was born at Wanstead in 1901, and commenced his seagoing career in sail, serving his apprenticeship with Messrs. J. Hardie & Co. and Messrs. Nisbet & Co.

He joined the P & O in July 1923 as 4th officer of the *Mantua*. In 1939 he was 2nd officer of the *Chitral* when she was taken over by the Admiralty and during the war he served in the Royal Navy, rejoining the P & O in December 1946 as Chief Officer of the *Perim*. He was promoted to Staff Captain of the *Strathmore* in December 1949 and his first command was the *Karmala* in January 1951. Thereafter he commanded *Socotra*, *Dongola*, *Aden*, *Patonga*, *Corfu* and *Strathnaver*.

Captain Banks is the last P & O Captain to hold a Master's "Square Rigged" Certificate. He has co-operated with the Meteorological Office since 1927 when he sent in his first logbook from *Moldavia*. Thereafter he sent logbooks from *Naldera* and *Kaisar-i-Hind* pre-war and since the war from *Socotra*, *Aden*, *Corfu* and *Strathnaver*. In 13 years he forwarded 19 logbooks, of which eight were classed 'excellent'. He received an Excellent Award in 1930.

We wish him health and happiness in his retirement. J. C. M.

RETIREMENT.—COMMODORE W. H. DOWNING, S.G.M., retired on 31st July last after 48 years at sea, all of which were served with the Manchester Liners.

William Henry Downing first went to sea as an Apprentice in the *Manchester Engineer* in 1913, passing for 2nd Mate in 1918 and Master in 1924. Passing through the usual grades from 3rd Officer in 1918, Commodore Downing was appointed to his first Command, the *Manchester Spinner*, in 1940. He subsequently commanded most of his company's vessels, his last command being the *Manchester Miller*, in which he served as Commodore since November 1960.

In recognition of the rescue of 45 members of the crew of the s.s. *Volumnia*, sunk in the Atlantic in November 1929, Commodore Downing was awarded the Sea Gallantry Medal.

By taking 'soundings' over a period from 1948 to 1959, he determined the existence and position of a shoal in the St. Lawrence River, details of which were submitted to the Admiralty and published in 1960. This shoal has been named "Downing Shoal" (Chart 824).

During both World Wars Commodore Downing was engaged in troop-carrying and convoy work.

Commodore Downing's record with the Meteorological Office dates back to 1921, and in 21 years he has sent in 53 logbooks, 21 of which were classed 'excellent'. In 1948 and 1951 he received Excellent Awards and in 1948 was presented with an inscribed barograph in recognition of his long and zealous voluntary service to the Meteorological Office.

Commodore Downing is succeeded as Commodore of the Manchester Liners by his brother, who has also served the whole of his seagoing career with that company.

We wish Commodore Downing health and happiness in his retirement.

J. R. R.

RETIREMENT.—CAPTAIN F. W. J. PEARCE retired recently when he brought the 30-year-old *Corfu* into London on her last voyage before going to the ship breakers.

Frederick Warren Jewel Pearce signed his indentures in May 1918 with the Marine Navigation Co. (better known to seamen by the name of their Director, Sir William Garthwaite), and was sent across to New York to join their four-masted barque *Juteopolis*. The influenza epidemic which is said to have caused greater loss of life than did the First World War itself was then raging, and thirteen apprentices were taken to hospital from the *Juteopolis* shortly after joining, three of whom died. The ship sailed six days before the war was over, but it was not until her arrival in Sydney, four months later, that the ship's company heard the glad news.

Juteopolis was renamed *Garthpool* in June 1920. Coming up channel she encountered the famous storm of March 1922 when a wind of 108 miles per hour was recorded at Scilly, the highest recorded in England up to that time. Meteorological records of the storm are somewhat scanty because the screens at Cattewater, Pendennis Castle and Beachy Head were overthrown, whilst at Lympne the whole meteorological observation post, an ex-Army trailer, was blown away and overturned. At Plymouth, many ships dragged their anchors, trees of 5 ft. in diameter were uprooted, whilst a roof 30 ft. × 15 ft. was lifted and carried a distance of about 1,000 yd. *Garthpool* was not an observing ship.

Captain Pearce next sailed on a two-year voyage as Acting 2nd Mate of the barque *Garthgarry*. The vessel was dismasted whilst homeward bound from Iquique and for Captain Pearce the voyage ended with a long spell of amoebic dysentery during which he was an early subject for an experiment with the drug Yatren.

After passing for 2nd Mate (square rigged) in 1925 he joined the Peninsular and Oriental S.N. Co. as 4th Officer of their s.s. *Delta*, remaining with the Company until his retirement.

He passed for Master in 1934, and sailed unharmed through the Second World War in the larger P. & O. ships employed mainly on trooping and in combined operations.

He was appointed to his first command, the *Perim*, in 1951 and commanded the *Empire Fowey* during the Ministry of Transport's trials of inflatable life-rafts in which a film was made for the Safety of Life at Sea Convention.

Captain Pearce tells us that his interest in meteorology dates from his earliest days for in 1887 his mother had been the first woman science graduate of London University. His record of voluntary observing for us goes back to 1923 when he was 2nd mate of the *Garthgarry*. From 1927 to 1937 he sent us meteorological logbooks from the *Balranald*, *Naldera* and *Moldavia* and since the war his meteorological logbooks have all come from the *Corfu*. He is probably the last of the present-day observers to have sent us observations from a deep-water sailing ship. "They mark our passage as a race of men, earth will not see such ships as those agen", wrote Masefield.

We wish him health and happiness in his retirement. L. B. P.

OBITUARY.—We regret to report the death, on 30th September 1961 at his home in Wokingham, near Bracknell, of Mr. P. R. BROWN, M.SC., A.R.C.S., D.I.C., who worked as a scientist in the Marine Division of the Meteorological Office from 1950 to 1960.

Paul Rodham Brown was born in May 1916 and joined the Meteorological Office as a technical officer in 1938; in 1939 he transferred to the Irish Meteorological Service, where he was employed at the original Shannon Airport flying-

boat base at Foynes, County Limerick. He rejoined the Meteorological Office in 1944, obtained a commission in the R.A.F.V.R. as a Flight Lieutenant in April 1945 and from 1946 to 1948 he served in the Far East (Burma, Singapore and Japan), during which time he was promoted to Squadron Leader. Released from the R.A.F. in 1948, he was prevented by a period of ill health from resuming work in the Meteorological Office until October 1950 when he joined the Marine Division as a scientific officer. He was promoted to senior scientific officer in 1954 and transferred to the Climatological Division in 1960, because of a reorganisation of the office.

Paul Brown was a very pleasant colleague with whom to work, in every way; he was hard working, outspoken and loyal and had a good sense of humour; he showed great interest in all aspects of maritime meteorology. During the first five years of his sojourn in the Marine Division he was primarily engaged on marine climatology and wrote papers on such varying subjects as the meteorological aspects of cargo ventilation; evaporation, humidity and condensation in enclosed spaces; climatic fluctuation in northern waters; humidity over the Atlantic; wave data for the eastern North Atlantic; and ice in the Newfoundland region. He was primarily responsible for the preparation of the present edition of *Monthly Meteorological Charts and Sea Surface Current Chart of the Greenland and Barents Seas.* During the second five years, he divided his time between climatology and the supervision and building up of the punched card installation, which was originally employed solely for work of the Marine Division, but gradually extended its activities to the work of the whole office. The efficient and comprehensive punched card installation which is now established at the Meteorological Office at Bracknell is a tribute to Mr. Brown's skill and ability. Throughout his stay in the Marine Division, he was also responsible for dealing with marine enquiries and he gave meteorological evidence at many formal investigations held by the Ministry of Transport into shipping casualties (including the *Flying Enterprise* and the *Sao Paulo*).

Two further papers by him, on the climatic fluctuations over the oceans since 1870, were read for him at the World Meteorological Organisation's recent Symposium on Climatic Change at Rome, a few days after his untimely death.

He leaves a widow and young son, to whom we extend our sympathy.

C. E. N. F., H. H. L.

Notices to Marine Observers

WEATHER INFORMATION AT SOUTHAMPTON

Forecasts and other weather information for the Southampton area may now be obtained from the Southampton Weather Centre, which opened on 14th December 1961. Mariners who wish to make use of this service will be welcome at the Centre, which is situated at 160 High Street below Bar, Southampton. The telephone number is Southampton 28844. The Port Meteorological Officer for Southampton, Lieut. Cdr. E. R. Pullan, R.D., R.N.R., has moved his office to the Centre, where he works in close co-operation with the forecasters. His telephone number is Southampton 20632.

The Centre is open from 9 a.m. to 6 p.m., Monday to Saturday, but forecasts can be obtained by telephone at any time of the day or night. Daily weather charts, covering Home Waters and the eastern North Atlantic to 35°W, between 40° and 67°N, are available to departing ships from 8.30 a.m. onwards. These include the synoptic situation at the previous midnight, a forecast chart for midnight of the day of issue, a statement of the general synoptic situation, gale warnings in operation, sea area forecasts, and a forecast for the Southampton area.

Forecasts for southern Hampshire and the Isle of Wight, including the Solent

area, which are prepared by the Centre, are now also available on the Automatic Telephone Weather Service by dialling Southampton 8091.

Note.—A list of forecasting offices and Weather Centres from which weather forecasts, etc., can be obtained for the various ports around U.K. coasts is given in *Admiralty List of Radio Signals*, Vol. 3, pp. 19–20, and in *Meteorological Office Leaflets Nos. 1* (which also includes details of the Automatic Telephone Weather Service in the various areas) and *3* (which also gives details of other services available to coastwise shipping and fishing vessels).

ADDRESS OF P.M.O. SOUTHAMPTON

The Port Meteorological Officer for Southampton has now left the Old Docks and has his office at the Southampton Weather Centre, 160 High Street below Bar, Southampton (telephone: Southampton 20632). (See above notice.)

SEA AND SWELL WAVES

Selected Ships are requested to record waves in the *lower* half of the space in the meteorological logbook, as the upper half is required for office use in connection with a new international punched card. A second swell group, where present, should be recorded in the Ice columns, which should be re-headed accordingly.

AUTOMATIC TELEPHONE WEATHER SERVICE

Recorded weather forecasts may be obtained by telephone for certain local areas. Those areas which may be of interest to mariners are: London, Essex coast, Kent coast, Sussex coast, S. Hants., Bristol, Cardiff, S. Lancs. and N. Cheshire, Belfast, Glasgow, Edinburgh.

Details may be obtained from local telephone directories or *Meteorological Office Leaflet No. 1.*

ERRATUM

The Marine Observer, October 1961. Page 200—

NOTES ON ICE CONDITIONS, line 3 from foot of page: *for* north-east of Russia *read* north-west of Russia.

Fleet Lists

Corrections to the lists published in the July 1961 number of *The Marine Observer* are printed below.

Information regarding these corrections is required by 20th October each year. Information for the July lists is required by 20th April each year.

AUSTRALIA (Information dated 3.10.61)

The following have been recruited as Selected Ships:

Agamemnon (A. Holt & Co.)
Arafura (Eastern and Australian S.S. Co., Ltd.)
Bamora (British India S.N. Co.)
Bermuda Trader (British Phosphate Commission)
Chakrata (British India S.N. Co.)
Koomilya (McIlwraith McEacharn & Co., Ltd.)
Mandama (Blue Star Line)
Montoro (Burns Philp & Co.)
Nankin (P. & O.—Orient Line)
Port New Plymouth (Port Line, Ltd.)
Shansi (China Navigation Co., Ltd.)

The following ships have been deleted:

Idomeneus, Koorawatha, Kooringa, Mandamor, Mandowi, Montmo

HONG KONG (Information dated 4.10.61)

The following ship has been deleted:

Lok Sang

INDIA (Information dated 21.10.61)

The following ship has been recruited as a Selected Ship:

Jalapadma * (Scindia S.N. Co., Ltd.)

The following ships have been recruited as Supplementary Ships:

Indian Triumph (India S.S. Co., Ltd.)
Jala Jageevan (Scindia S.N. Co., Ltd.)
Jalakrishna (Scindia S.N. Co., Ltd.)
Jalapratap (Scindia S.N. Co., Ltd.)
State of Bihar (Shipping Corporation of India, Ltd.)
State of Uttar Pradesh (Shipping Corporation of India, Ltd.)
Vishva Kirti (Shipping Corporation of India, Ltd.)
Vishva Usha (Shipping Corporation of India, Ltd.)

The following ships have been deleted:

Nadir, Jalakendra

MALAYA (Information dated 11.10.61)

The following ships have been recruited:

Hoi Houw (Boustead & Co., Ltd.)
Kuda Mas (Guan Guan, Ltd.)

The following ship has been deleted:

Matang

NEW ZEALAND (Information dated 3.10.61)

The following ship has been deleted:

Port St. John

GREAT BRITAIN (Information dated 10.10.61)

The following coasting vessels ('Marid Ships') have been recruited:

Name of Vessel	Captain	Owner/Manager
Angularity	R. H. Golding	F. T. Everard
Arnhem	A. P. Sutton	British Transport Commission
Ballylagan	A. Barron	John Kelly, Ltd.
Bardic Ferry	R. Hockings	Atlantic S.N. Co.
Devon Coast	W. Grogan	Coast Lines, Ltd.
Duke of York	R. Good	British Transport Commission
Fauvic	H. S. Shugar	Channel Shipping, Ltd.
Hydracrete	E. Warman	Wm. Cory & Sons
Irish Coast	J. McKinnon	Coast Lines, Ltd.
Karri	D. Hill	W. N. Lindsay
Lapwing	M. English	General S.N. Co., Ltd.
Ringdove	J. S. Likis	General S.N. Co., Ltd.
Sarnia	C. Cartwright	British Transport Commission
Seamew	W. H. Conway	General S.N. Co., Ltd.
Superiority	J. Gardner	F. T. Everard
The President	—. Hay	J. Hay & Sons

The following skippers and radio operators have been added to the Trawler Fleet List:

Skipper	Radio Operator	Trawler Owner/Manager
G. Atherton	S. Waterman	Charleson-Smith Trawlers, Ltd.
F. Burnett	M. McKinnon	Don Fishing Co.
P. Craven	D. L. Verity	St. Andrews Steam Fishing Co., Ltd.
A. Jackson	G. A. Holiday	Kingston Steam Trawling Co., Ltd.
F. Myers	A. Ramsay	Charleson-Smith Trawlers, Ltd.
T. Whitley	A. Ramsay	Charleson-Smith Trawlers, Ltd.

The following ships have been deleted: *Araby, Armagh, Brisbane Star, British Patience, City of Bristol, Clan Campbell, Clan Davidson, Clan Lamont, Clan MacBrayne, Corfu, Corrales, Daleby, Deerpool, Dunkyle, Empire Cymric, Empire Star, Esso Manchester, Garlinge, Grebe, Hartington, Isle of Guernsey, Lalande, Media, Naticina, Novelist, Port Hardy, Prospector, Reynolds, Rippingham Grange, Rookwood, St. Ninian, San Velino, Saxon Star, Scottish Star, Seattle Star, Strathaird, Taranaki, Volo, Worcestershire, Zena.*

* Formerly a Supplementary Ship.

GREAT BRITAIN (cont.)

The following ships have been recruited as Selected Ships:

Name of Vessel	Date of Recruitment	Captain	Observing Officers	Senior Radio Officer	Owner/Manager
Alert	2.9.61	J. P. Ruddock	D. Alford, D. MacDonald, A. Fulton	—. MacDonald	H.M. Postmaster General
Anselm	14.6.61	J. Whayman, D.S.C. & bar, R.D.	J. Igoe, D. Lewis, J. Brierly	A. Newcombe	Booth Line
Arthur Albright	13.6.61	S. J. Bristow	T. Ball, W. Bainbridge		James Fisher & Co., Ltd.
Bombala	14.9.61	F. A. Everett	K. B. Harle, H. B. Chambers, D. W. Walker	E. A. Rogers	British India Line
Cambridge	16.8.61	S. G. Robinson	W. R. Nisbet, P. E. Robertson, D. I. Jamison, C. J. Davies	P. Wither	Federal Line
Canterbury Star	20.3.61	W. Pitcher			Blue Star Line
Cheviot	12.5.61	G. Robison	R. Phillips, B. Longley, P. E. P. Liddell	J. Middleton	Bamburgh Shipping Co., Ltd.
Clan Macnab	24.5.61	T. A. Watkinson	R. M. Fowlkes, M. N. Ure, G. Sked	R. W. Moore	Clan Line
Crinan	31.3.61	W. Tawse	R. Gibb, W. Howat, J. Ingles	D. Byron	J. & J. Denholm, Ltd.
Empress of Canada	14.4.61	J. P. Dobson, C.B.E., D.S.C., R.D.	D. Williams, A. Brewer, J. Emmanuel	P. McNab	Canadian Pacific Line
Herefordshire	9.9.61	A. E. Young	J. Ablett, M. Reeves, J. Wilkinson, J. W. Waldie	R. Ferry	Bibby Line
Kohistan	12.6.61	C. S. Bartlett	W. Mackenzie, R. H. Barr, A. C. McCulloch	L. J. Kidd	Strick Line
Manchester Explorer	20.4.61	L. Taylor	J. McMasters, A. Copeland, —. Bramhall		Manchester Liners
Manchester Shipper	24.3.61	T. H. Lynn	—. Hogg, —. Higgins, T. W. Rourke	W. Baldwin	Manchester Liners
Maron	1.5.61	C. F. Lock	G. Wood, G. M. Cameron, P. D. Crouch	G. T. Pearce	Ocean Steamship Co.
Newcastle Star	19.9.61	R. S. Hopper, D.S.C.	J. McNiel, A. Woods, G. Piggott	J. Clark	Blue Star Line
Port Townsville	19.7.61	J. S. Moate	J. Burtt	E. Loft	Port Line
Salmela	29.3.61	W. Hay-Spence	P. Sinclair, G. Barrie, M. Dunkerley		Chr. Salvesen & Co., Ltd.
Serenia	22.6.61	J. C. Nettleship	C. J. Burls, M. Laws, P. H. Adlam, H. Rockett		Shell Tankers, Ltd.
Silverpoint	28.6.61	D. G. Roberts	R. W. Overton, P. Ubsdall		Silver Line
Trinculo	5.7.61	F. H. Simpson	R. A. Reay, W. R. Pilling, N. Clay	D. Broadbridge	C. T. Bowring & Co., Ltd.
Yorkshire	30.5.61	—. Cooper	—. McDermott, R. Weir, J. Rice	J. P. Monaghan	Bibby Line

The following ships have been recruited as Supplementary Ships:

Dartwood	15.8.61	W. Manson	B. Taylor, J. Potter	M. Lebbon	Wm. France, Fenwick & Co., Ltd.
Denbighshire	19.7.61	T. R. Walker	D. J. Metcalf, D. H. Hammond, R. L. Flinders	E. Power	Glen Line
Mangla	3.8.61	J. B. Newman	P. F. Blackburn, P. A. Gunson, A. Pittendrigh, S. Torkington	W. Rich	Brocklebank Line
Manipur	27.7.61	J. P. Brand	D. Peters, D. F. Barratt, G. A. Jenkins	A. Dunn	Brocklebank Line
Prome	21.9.61	E. W. Campbell	A. B. Crawford, A. B. Walker, W. Fitzgerald	A. Gilbert	Henderson Line
Tudor Prince	4.10.61	A. Kent	G. Hughes-Jones, B. Ditchburn, C. Robins		Prince Line

SCIENTIFIC PAPERS

A new series designed to replace the series of *Meteorological Reports* and *Professional Notes*. Giving the results of investigations made in the Meteorological Office, it will include monographs both on pure meteorological research and on the application of meteorology to transport and industry. The format has been enlarged to enable the diagrams, always an important feature of meteorological publications, to be larger and clearer. Titles available are listed below:

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No. 5 **An Experiment in Numerical Forecasting.** By E. Knighting, B.Sc., G. A. Corby, B.Sc., F. H. Bushby, B.Sc., C. E. Wallington, M.Sc. 5*s.* (post 5*d.*)

No. 6 **Seasonal Variation of the Sea Surface Temperatures in Coastal Waters of the British Isles.** By F. E. Lumb, M.Sc. 3*s.* (post 4*d.*)

No. 7 **Forecasting in Falkland Islands and Dependencies.** By S. D. Glassey 3*s.* 6*d.* (post 4*d.*)

No. 8 **Factors Associated with the Formation and Persistence of Anticyclones over Scandinavia in the Winter Half of the Year.** By M. K. Miles, M.Sc. 3*s.* (post 4*d.*)

No. 9 **An Experiment in the Verification of Forecasting Charts.** By C. E. Wallington, M.Sc. 4*s.* (post 4*d.*)

No. 10 **Incidence of, and some rules of Forecasting Temperature Inversions over he North-East Atlantic.** By H. C. Shellard, B.Sc., and R. F. M. Hay, M.A. 3*s.* (post 4*d.*)

Obtainable from

HER MAJESTY'S STATIONERY OFFICE

or through any bookseller

Meteorological Office (Marine Division) Atlases

The following are published by the Marine Division of the Meteorological Office and may be purchased from the bookshops of Her Majesty's Stationery Office at any of the addresses on the title page. Copies are available for reference by shipmasters and shipowners in the offices of Port Meteorological Officers.

Meteorological Atlases

Monthly Meteorological Charts of the Atlantic Ocean. M.O.483, 1948, reprinted 1959. (60°S–70°N, 80°W–40°E) 180*s.* (post 3*s.* 3*d.*)

Monthly Meteorological Charts of the Western Pacific. M.O.484, 1945, reprinted 1956. (60°S–60°N, 100°E–155°W) (16¾″ × 23¾″) 105*s.* (post 2*s.* 9*d.*)

Monthly Meteorological Charts of the Eastern Pacific. M.O.518, 1950, reprinted 1956. (60°S–60°N, 160°W–60°W) (17½″ × 24½″) 147*s.* (post 3*s.* 3*d.*)

Monthly Meteorological Charts of the Indian Ocean. M.O.519, 1949, reprinted 1959. (50°S–30°N, 20°E–120°E) (16½″ × 22½″) 126*s.* (post 2*s.* 9*d.*)

The above four atlases contain monthly charts of wind, barometric pressure, air and sea temperature, and other meteorological elements including some typical tracks of tropical revolving storms.

Monthly Sea Surface Temperatures and Surface Current Circulation of the Japan Sea and Adjacent Waters. M.O.M.447, 1950. (20°N–47°N, 110°E–150°E) (20″ × 17″) 7*s.* 6*d.* (post 9*d.*)

Monthly Sea Surface Temperatures of Australian and New Zealand Waters. M.O.516, 1949. (50°S–10°S, 100°E–180°) (19¾″ × 12¼″) 10*s.* (post 7*d.*)

Monthly Sea Surface Temperature of the North Atlantic. M.O.527, 1949, reprinted 1950. (30°N–68°N, 80°W–15°E) (19¾″ × 12¼″) 10*s.* (post 7*d.*)

Monthly Meteorological Charts and Sea Surface Current Chart of the Greenland and Barents Seas. M.O.575, 1959. (60°N–80°N, 30°W–120°E) 126*s.* (post 2*s.*)
This atlas contains a generalised surface current chart for the area and monthly charts of wind, barometric pressure, air and sea temperature, and other meteorological elements.

Current Atlases

Currents of the Indian Ocean. M.O.392, 1939, reprinted 1956. (50°S–30°N, 20°E–140°E) (30″ × 20″) 10*s.* (post 7*d.*)

South Pacific Ocean Currents. M.O.435, 1938, reprinted 1959. (60°S–0°, 140°E–70°W) (22″ × 34″) 12*s.* 6*d.* (post 1*s.*)
The above two atlases contain quarterly "current arrow" and "current rose" charts.

Quarterly Surface Current Charts of the Atlantic Ocean. M.O.466, 1945, reprinted 1957. (60°S–70°N, 80°W–20°E) (22½″ × 18″) 32*s.* 6*d.* (post 1*s.* 6*d.*)

Quarterly Surface Current Charts of the Western North Pacific Ocean with monthly chartlets of the China Seas. M.O.485, 1949. (0°–60°N, 98°E–160°W) (21″ × 16″) 25*s.* (post 11*d.*)

Quarterly Surface Current Charts of the Eastern North Pacific. M.O.655, 1959. (0°–60°N, 160°W–65°W) (23″ × 17″) 15*s.* (post 10*d.*)
The above three atlases contain current rose charts, predominant current charts, and vector mean current charts.

Ice Atlases

Monthly Ice Charts of the Arctic Seas. M.O.M.390a, 1944. (60°N–80°N, 80°W–110°E) (12″ × 7″) 3*s.* 6*d.* (post 5*d.*)
Polar ice, mean limits of sea ice, extreme limits of sea ice, extreme limits of bergs.

Monthly Ice Charts of Western North Atlantic. M.O.478, 1944. (37°N–53°N, 72°W–35°W) (12″ × 7½″) 4*s.* (post 7*d.*)
Mean limits of pack, extreme limits of pack, mean limits of bergs, extreme limits of bergs.

Climatological Charts

Climatological and Sea-Surface Current Charts of the North Atlantic Ocean. M.O.615, 1958. (5°S–60°N, 100°W–40E°) (40″ × 25″, folded to 13″ × 8″) 36*s.* the set (37*s.* with folder) (post 1*s.* 2*d.*)
One chart for each month, based on information in M.O. 483, M.O. 466 and M.O. 478 (above).

Her Majesty's Stationery Office

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